Natural Science

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NOTES AND COMMENTS.

Distribution and Morphology.

IN an essay of 60 pages, entitled "Grundzüge der geographisch-morphologischen Methode der Pflanzensystematik," (G. Fischer, Jena,) Dr. Wettstein of Prague University has made a useful and suggestive contribution to the literature of systematic botany. The scientific systematist is no longer satisfied with adding new species or genera to the roll of names; he aims at establishing affinities between those already known, in a word, the study of their phylogeny. But there is great danger of losing oneself in theory and speculation, and any objective method of comparison is welcome. Palaeontology and ontogeny have proved of service in delimiting and determining the relationships of larger groups, as, for instance, the Fern allies (Pteridophyta), and the Gymnosperms and the Angiosperms. But in dealing with the higher subdivisions, genera, and species, these are useless, and it is here that Dr. Wettstein steps in with his geographic-morphological method. Morphology, though an excellent guide to affinities, is not always trustworthy, as, for instance, in the cases of seasonal dimorphism, which the author has described in certain Gentians, and species of *Euphrasia*, where late-flowering and early-flowering forms of the same species have quite differently shaped leaves, and show also differences in stem-development.

The object of the essay is to show how facts of geographical distribution may be used as a guide to the systematic arrangement of the members of a polymorphic group of species. As examples, Dr. Wettstein selects a group of European Gentians and Euphrasias. Thus the range of fourteen European species of *Gentiana*, section *Endotricha*, is depicted on one map, and the result is confusion. When, however, separate maps are devoted to each set of species, the distribution areas of which adjoin, it is seen that there are three distinct sets. As each set has, moreover, certain morphological characters in common, the author maintains that this combination of geographical and morphological considerations has elucidated three natural groups, and emphasises this conclusion by subordinating

the members of each group as sub-species of one species, which he regards as the archetype.

It is obvious that a satisfactory application of this method is possible only in cases where the geographical distribution has been approximately worked out, and, like any other method, its operation must not be pushed too far. It should at any rate prove of service to those who are working at floras of limited areas, and to such especially we would commend a careful perusal of Dr. Wettstein's essay.

Irrelevant Generalities.

THE biological inquirer of to-day is like the fisherman of the old story who tapped a flask on the sea-shore and let loose a cloudy genie; he explores a concrete object, it may be the sperm-cells of a snail or the wings of an insect, and forthwith there emerges upon him and upon us a looming cloud of "allgemeine Betrachtungen," the genie of general biology, who will in nowise return to his flask. So far, doubtless, it is well that every research should have a wide horizon; but anyone who has read, say, the papers of the last five years relating to spermatogenesis, will surely agree with Mr. Bernhard Rawitz (*Arch. f. mikr. Anat.* 1898, liii. p. 20), that the generalising tendency is often as irrelevant as it is tedious. It is not necessary that everyone should point out every time how the often small item of new fact which has been securely established by his research bears upon the problems of cell-division, fertilisation, heredity, and the like, "ohne dass dabei ein erkleklicher wissenschaftlicher Gewinn abfiel." "Very many authors," says Rawitz, and he has our sympathetic concurrence, "seem to me like a geographer who describes the province of Brandenburg and hangs on to that a discussion of the whole physical geography of the northern hemisphere." We know of irrelevant detail, like that of the venerable geologist who could not discuss graphite without bringing in the life-history of the Faber family; but there are irrelevant generalities as well, and it is hard to say which are most exasperating.

The Chinch Bug.

IN volume viii. of *Natural Science* (p. 376) reference was made to Mr. F. M. Webster's studies on the distribution of the Chinch Bug (*Blissus leucopterus*, Say) in North America. An exhaustive monograph on the insect by the same naturalist has just been issued as Bulletin 15 (N.S.) of the Entomological Division of the U.S. Department of Agriculture. Though intended primarily for the farmer's use—

the Chinch Bug being one of the six most destructive insects in the States—this work contains much to interest the general student of insect life. The severity of the attacks by the bugs on corn and grasses is largely due to their gregarious habits. They have but few natural enemies, but high mortality is at times caused among them by certain fungi, notably *Sporotrichium globuliferum*. Reference to the attempted utilisation of this fungus-disease for their destruction has already been made in *Natural Science* (vol. ix. pp. 6-7). Mr. Webster believes that artificial inoculation could only be worked successfully if the bugs were excessively numerous in wet weather or in damp situations.

With regard to the origin and diffusion of the species, Mr. Webster brings forward evidence to show that there have been three principal northward lines of migration from tropical America: a western, along the Pacific coast to California; a central, from the Gulf coast of Texas northward to Winnipeg; and an eastern, along the Atlantic seaboard to Nova Scotia. All the adults of the central migration have fully developed wings, but among the eastern race forms with vestigial wings are common. These latter have spread eastward and north-eastward, and in their progress through the New England States have acquired a habit of ravaging grass meadows, which is rarely practised by the bugs of the central migration.

Several species of *Blissus* inhabit Europe and Africa, but we can hardly accept Mr. Webster's suggestion that the ancestors of the American Chinch Bug were carried across the ocean by the equatorial currents.

Formation of a Human Race.

In his treatise on in-breeding and crossing in man ("Inzucht und Vermischung beim Menschen," Leipzig, 1897), Dr. Albert Reibmayr brings much erudition to bear upon an old problem, the respective rôles of in-breeding and crossing. Close in-breeding is necessary to fix and ennoble a race, but when it is prolonged, or if the material be poor, there is continual risk of weakness, infertility, and degeneration. But it is through in-breeding that a national character is evolved, and the problem of national eugenics is to watch for the crisis when crossing becomes necessary to obviate degeneracy. Thus in history there have been and must be alternating periods of dominant in-breeding and dominant cross-breeding. In America, the author indicates, a new race is being formed by complex cross-breeding, a new race which will lead mankind to new ideals in spite of the reactionary doctrine "America for the Americans." And behind this prophecy—which is always rather gratuitous—there is no small amount of solid anthropological measurement and statistic.

Do Salmon feed in Fresh Water?

In the *Report of Investigations on the Life-History of Salmon* (Fishery Board for Scotland, 1898), edited by Dr. Noël Paton, there are two papers—by Dr. G. Lovell Gulland and by Dr. A. Lockhart Gillespie—which bear directly on the long-disputed question whether salmon feed while in fresh water. The Edinburgh workers agree with Miescher-Reusch (1880) in answering the question in the negative, thus differing from a well-known Scottish authority—Prof. W. C. M'Intosh. The evidence adduced in the Report is threefold:—(*a*) During the salmon's stay in fresh water the mucous membrane is in a state of desquamative catarrh which suggests a cessation of function. This is corroborated by the absence of zymogen granules in the pancreas, the fatty condition of the liver, the emptiness of the gall bladder, and the absence of all trace of food. (*b*) Experiment showed that the proteolytic and diastatic action of the digestive secretions was extremely low. (*c*) The number of bacteria in the gut is very great, especially during the warm months, and this is interpreted as probably due to the diminished acidity of the gastric fluids. This is, of course, merely a hint of the nature of the actual evidence, which seemed to us so convincing, when we first read it, that we were rash enough to think that the question was settled at last.

It seems that this is not so. In a paper in the *Zoologischer Anzeiger*, 1898, xxi. pp. 514, 515, 517-523, Dr. Alex. Brown, Lecturer in Zoology in the University of Aberdeen, who has had great facilities in studying salmon, maintains that though the river fish are not in a condition to feed voraciously as in the sea, they do feed occasionally, much depending on external conditions, such as the temperature, density, and volume of the water. He does not find any trace of the catarrhal conditions observed by Dr. Gulland, except as the result of post-mortem changes; but he finds microscopic foreign particles and crystals of carbonate of lime in the intestine, which are the indigestible remains of ingested food. Moreover, the presence of leucin crystals in abundance and of tyrosin in the intestine point to the decomposition of proteid by the pancreatic juice; and the pyloric and intestinal contents have a strongly active digestive character. Two more contradictory sets of results it would be hard to find; and we look with eagerness for a reply from the Edinburgh laboratory. It is difficult to believe that an expert histologist was deceived by post-mortem changes.

None of the investigators have as yet thrown light upon the fact that the salmon, alleged to be fasting, will still rise to the fly, or accept a prawn. We suspect that the explanation will be found to be psychological rather than physiological.

The Mackerel and its Variations.

NUMBER 3 of volume v. of the new series of the *Journal of the Marine Biological Association* was published at Plymouth towards the end of November. It contains an important article on the "Variation, Races, and Migrations of the Mackerel (*Scomber scomber*)," by Walter Garstang.

This is an attempt to determine whether there are any racial peculiarities in groups of mackerel taken in different localities. Such peculiarities have not hitherto been recognised, even as between American and British representatives of the species; but it is clear that the establishment of such peculiarities would affect to a considerable degree our ideas concerning the migrations of this fish.

Mr. Garstang has determined the peculiarities of more than 1600 mackerel from various localities, in regard to ten chosen characters of which the following are the chief:—

A. The number of black transverse bars or stripes on one side (the left) of the fish. B. The number of transverse bars on one side (the left) which cross or meet the lateral line. C. The presence or absence of round black spots ("intermediate spots") between the bars of series A. The variation of this character is tabulated under two heads:—(1) The number of fish per centum which possess one or more of these intermediate spots, and (2) the total number of such spots per hundred fish (the left side only of each fish being considered). D. The number of rays in the first dorsal fin. E. The number of rays in the second dorsal fin, including any incipient finlets which are still partially connected with the fin by a low web or ridge, or which are merely closely approximated to the fin and erectile with it. F. The number of dorsal finlets, including all incipient finlets described under E.

The American mean values for several of the characters, especially A, B, C, and F, differ to such an extent from the British means, that there can be no further doubt as to the existence of racial peculiarities which distinguish American from British specimens of the mackerel. As compared with the British mackerel, the American fish possesses the following racial characteristics—(1) A higher number of transverse bars, (2) much greater spottiness, (3) a smaller number of fin-rays in the second dorsal fin, and (4) a greater number of dorsal finlets. These characteristics are *average* distinctions, and do not suffice to distinguish every individual.

With regard to the British fish, the range of variation is very limited, especially in the case of the second dorsal fin, the greatest deviation from the general mean value of which does not amount to $\frac{1}{10}$ of a fin-ray in any sample of 100 fish. The total number of fish from the various localities is seen to be insufficient in this case to afford a basis for the establishment of racial differences. In the case

of the first dorsal fin the variation is greater, but here the difficulty of accurately determining in all instances the exact number of fin-rays present (owing to the extreme minuteness of the posterior rays) has also provided an obstacle to very definite results. Nevertheless Mr. Garstang comes to this "paramount conclusion":—That the mackerel which frequent British waters are not exactly alike in all localities, but possess certain average peculiarities which distinguish one local race from another. These peculiarities are greatest between the races of localities which are geographically remote, and least between those which occupy areas that are geographically contiguous. Between the mackerel of the North Sea and English Channel there are no differences at all; but the Irish race is distinctly divisible into two stocks, one of which is restricted to the west coast, the other to the south. A considerable amount of mixture takes place between the southern Irish stock and the fish which frequent the mouth of the English Channel. The western Irish stock represents more closely than any other race the primitive type of mackerel from which all, whether British or American, have been derived.

If these results be accepted or confirmed, the problems of the migrations of the mackerel and of its winter home are considerably simplified. The Irish fish in winter must remain off their own coasts, or they would lose their peculiarities by mixture with other races. The North Sea and Channel fish probably have the same winter haunts off the mouth of the English Channel—not too far to the westward, or they would mix with the Irish fish. That the North Sea fish migrate into the Channel in winter is rendered probable by the enormous concentration of mackerel in the southern part of the North Sea in autumn, and by the prolongation of the mackerel fishery far into the winter off the Devon and Cornish coasts of the Channel, long after the fish have disappeared from the North Sea and the Irish coasts alike.

The paper is one of the highest importance to both systematists and practical fishermen.

The Plymouth Laboratory.

OTHER papers contained in the same number of the *Journal of the Marine Biological Association* are:—"Report on Trawling in Bays on the South Coast of Devon," by E. W. L. Holt, with an Appendix by F. B. Stead. "Notes on *Pontobdella muricata*, the Skate-leech," by Hon. Henry Gibbs. "Notes on the Reproduction of Teleostean Fishes in the South-Western District," by E. W. L. Holt and L. W. Byrne. "The Great Silver Smelt, *Argentina silus*, Nilss. An addition to the List of British Fishes," by E. W. L. Holt, who gives the correct locality as 50° 20′ N. and 8° 25′ W., or about 75 miles true S. of the Old Head of Kinsale; depth 74 fathoms. This sensibly extends the range of

A. silus in a southerly direction; the specimen is now in the British Museum. Other occurrences recorded in this number are:—The Gobiid fish, *Callionymus maculatus*, near Plymouth; the Teleostean, *Phrynorhombus unimaculatus*, four miles S. of Plymouth Mewstone; the Gadid fish, *Motella cimbria*, from the stomach of a hake in the Bristol Channel; *Sepia elegans*, on trawling-grounds inside the Eddystone; *Mysis longicornis*, in Start Bay, S. Devon, not previously known outside the Mediterranean; *Mysidopsis angusta*, from the same locality, previously not farther S. than the Dogger Bank, but lately also recorded by A. O. Walker from Valencia Harbour, on the west coast of Ireland.

Colours of Cowries.

To *Knowledge* for December, Mr. R. Lydekker contributes an article upon the colours of cowries, illustrated by a full-page photographic plate. The interesting way in which the shells under consideration change during their growth from a thin-lipped form with a spire, as well shown by a series of skiagraphs in *Science Gossip* for June of last year, is briefly touched upon; while the alterations in colour, rendered so easy by the hiding of the older by the more recently formed whorls and the application of pearly matter to the outside of the latter, is discussed in some detail.

Mr. Lydekker is unable to throw any new light upon the object served by the colouring of adult cowries, nor does he suggest why the dark longitudinal bandings (which he calls transverse) of immature shells, presumably primitive and laid down by the edge of the mantle, should often be replaced by spots or uniform pigmentation derived from the pallial surface.

Nevertheless, the remarks show that many interesting problems remain to justify a further study of cowries, and the paper affords a useful illustration of the more striking types of coloration. Perhaps the most striking of the spotted series is not dwelt upon, to wit, the form with, for instance, a brown ground colour broken by white spots, the larger of which in turn have a very dark brown dot on their centre.

The plate would have been better entitled the markings of cowries seeing that it is not coloured, and it is hoped that it will not be taken as the best that photography can do for the conchologist. One is constrained to say conchologist, for the article ends with an uncalled for outburst against the biological method of studying molluscs. At the beginning of the change for the better about which Mr. Lydekker is not correctly informed, attention was naturally turned to the "so-called animal," our ignorance of the habits of which is so well brought out in the "colours of cowries," rather than to the points in connection with the shells which have been known for generations.

The Fishes of Lake Tanganyika.

CONSIDERING the remarkable remnants of a Jurassic marine fauna discovered by Mr. J. E. S. Moore among the mollusca of Tanganyika, the collection of fishes made by him at the same time is of a very disappointing nature. According to Mr. Boulenger's detailed and beautifully illustrated report just issued (*Trans. Zool. Soc.* xv. pp. 1-30, pls. i-viii.), all these fishes are typical modern freshwater forms such as might be found in any part of tropical Africa. The most abundant and varied species belong to the well-known family universally described in standard works under the name of Chromidae, but here termed Cichlidae in accordance with the latest fad of literary "research." The Tanganyika types of this family, indeed, are so varied that they have necessitated the establishment of nearly as many new genera as were previously known from the whole of Africa. There are three species of the spiny eel-shaped fish, *Mastacembelus*, six siluroids, three characinoids, and one representative of each of the families Serranidae, Cyprinidae, and Cyprinodontidae. There is also an undetermined species of *Polypterus;* and Mr. Boulenger adds that *Protopterus annectens* has been recorded by Sir H. H. Johnston. In an appendix, however, Mr. Moore points out that his collection probably gives as inadequate an idea of the fish-fauna of Lake Tanganyika as would a haul on the rocky coast of the Isle of Wight in reference to the fish-fauna of the English Channel. Most of the interesting molluscs, sponges, and so forth, inhabit only the deeper waters of the lake; and the fishes lying at these depths are still entirely unknown. Moreover, large fishes which bite the paddles of canoes have been seen in the open water away from land, but none of these have yet been captured. Ichthyologists, therefore, look forward with great interest to the results of Mr. Moore's projected second expedition, when he will be equipped with more effective means of netting and dredging this and some of the other great lakes. Meanwhile, it is necessary to suspend judgment and postpone speculations as to the meaning of the remarkable fauna in question.

Zoological Notes from Japan.

VOLUME II. Part III. of *Annotationes Zoologicae Japonenses* was published on October 10, 1898. The first paper is by Seitaro Goto and Shinkichi Hatai, on Japanese earthworms of the genus *Perichaeta*. It describes sixteen new species; but to European workers the most interesting point will be the statement that all previous describers of *P. sieboldi*, from Horst to Rosa, have been mistaken as to the position of the spermathecae. A renewed examination of the specimens in European museums is called for.

Seitaro Goto, in the following paper, claims to prove that in the

star-fish *Asterina gibbosa* the various divisions of the adult body-cavity are derived from portions of the larval body-cavity, different to some extent from those portions that give rise to them in *Asterias pallida*. In so far as this is proved, we might infer that the development of the species in question cannot be utilised in constructing a morphology for the Asteroidea as a class. Professor Goto incidentally corrects certain observations and conclusions by E. W. MacBride. Unfortunately the paper still lacks complete illustration and proof from sections. This we are promised in a paper to be published in the *Journal of the College of Science, Tokyo*. In the third paper Professor Isao Ijima describes *Amœba miurai*, a new Rhizopod parasite of man.

Nucleus and Cytoplasm.

In a paper read at the December meeting of the Royal Physical Society, Edinburgh, Miss L. H. Huie supplemented her previous observations (*Quart. Jour. Micr. Sci.* 1897, xxxix. pp. 387-425, 2 pls.) on the changes in the tentacles of the sun-dew produced by feeding. She finds that substances applied to the tentacles of *Drosera* affect either the cytoplasm alone, or both cytoplasm and nucleus. The cytoplasm reacts to physical irritation, and also to chemical substances which serve as foods. The nucleus is only affected by substances acting as food, the rate and amount of changes in the nuclein depending on the facility with which the food is absorbed. This agrees with Dr. Gustav Mann's view that the cytoplasm should be regarded as a specific environment secreted by the nucleus of each cell for the purpose of selecting and modifying potential food-stuffs which come into contact with it, and within physiological limits protecting the nucleus against detrimental conditions.

The Natural History of the Congo.

Naturalists will learn with great interest that the Government of the Congo Free State has arranged to investigate the botany, zoology, anthropology, ethnology, and geology of the vast region of Africa under its jurisdiction, and proposes to issue a series of exhaustive monographs detailing the results. The series is to bear the general title, *Annales du Musée du Congo*, the nucleus of the Museum being the collection displayed at the Antwerp exhibition in 1894. E. de Wildeman and Th. Durand, of the Botanical Garden of Brussels, are occupied with the study of the flora. The zoologists who have already begun the task are G. A. Boulenger, Ph. Dautzenberg, Alph. Dubois, Seel-drayers, and Vincent. Anthropology is entrusted to Dr. Victor Jacques and Professor Stainier; while ethnology will be undertaken by Th. Masui, director of the whole work. The geology will be investi-

gated by Dr. Cornet of Mons and Professor Stainier. There will also be special monographs descriptive of different districts of the territory.

The first instalment of this great and important work has just appeared, and further issues are promised at intervals of about three months. The part now before us is the first fasciculus of Boulenger's description of the fishes of the Congo, a handsome quarto with nine plates, most of them folded and representing the animals of the natural size. The extraordinary fishes of the family Mormyridae are here treated with a wealth of illustration hitherto unattained, greatly extending our knowledge both of genera and species. No less than three genera and nineteen species are added to those already known. These fishes seem to seek their food either in mud or in crevices between rocks (unfortunately Mr. Boulenger gives us no information as to the circumstances of life of any of them); hence they exhibit most remarkable modifications of the curved and elongated rostrum which bears the small mouth at the tip. The preliminary labelling of these strange animals having been accomplished, biologists will now await with great interest some scientific observations on the phenomena they present for study. The other fasciculus published is botanical.

The Evolution of Immunity.

ACCORDING to Dr. Albert Reibmayr, it is one of the functions of the physician to exorcise the evil spirits of anxiety and pessimism, and this is the aim of his last pamphlet, "Die Immunisirung der Familien," Leipzig und Wien, 1899. It is "ein Wort zur Beruhigung," a protest against "ghosts." His argument is not a novel one, but it is powerfully stated. It is this. Morbid conditions and tendencies are inherited, but relative immunity is also inherited, and the struggle is between them. In the course of natural selection, keenest during the early years of life, the less immune tend to be eliminated, and the standard is thus raised. But in this struggle the most momentous factor is in the external conditions of function and environment, for if these favour the morbid inheritance the organism has to fight a battle with two fronts which is seldom hopeful. The families which lay themselves open to this double struggle tend to be eliminated, especially on the male side, for the females, who often live a more natural life, and are more enduring, may keep up the strain of immunity. It may be recalled that in Ehrlich's experiments on immunity to ricin poisoning in mice, it was only through the females that any hint of inherited (?) immunity was detected, the relative large size of the ovum, with its affectable non-idioplasmic material, having perhaps to do with this.

It may be said, then, that there are two main prophylactic processes—(*a*) the increase of constitutional immunity in the course of

natural selection, and (*b*) the living of a healthy life, along with which may be included the hygienic devices which make for the elimination of microbes. Our author believes that carefully discriminated statistics show a decrease in the number of severe and fatal attacks. The cry "Back to a more natural life" is, he says, an instinctive one, which is becoming more and more general, and it is the voice of reason. It is plain, however, that there is another side to the question, which Haycraft emphasised in his "Darwinism and Race Progress"—If the race eliminates its own eliminators (the disease germs) which have at least helped to make it what it is, if it becomes no longer susceptible to their eliminative action, what selective agents—even more discriminating, let us hope—are to take their place? But how the human race is to get along when bacteria have ceased from troubling is not a pressing problem, and Dr. Reibmayr does not raise it in his "Wort zur Beruhigung."

Photographic Process Colour Printing.

THE publication of the well-known series of coloured photographic process views of scenery made it evident that similar processes would be soon employed for the illustration of zoological books, and we have just seen what we believe to be the first application of this method of illustration to birds. The pictures in question appear in "Birds that Hunt and are Hunted," by Neltje Blanchan, which was published in 1898 by Doubleday and M'Clure, of New York. Forty quarto plates of birds, with 360 pages of text, are issued at the low price of two dollars. The illustrations leave little to be desired, and some of them are perfectly lifelike, notably the Pintail Duck and the Teal, while the coloration of the Passenger Pigeon is perfect. These plates are produced by the Nature Study Publishing Company of Chicago, and are well worthy the attention of those who publish similar books in this country. All the exquisite pencilling of the feathers is shown in a way far superior to that produced by lithography, while the cost is infinitesimal as compared with that of an artist. We are sorry that the lithographic artist will have to go, but we are glad that birds can at last be presented with an accuracy that renders their identification easy.

A Noble Gift.

THE Annual Report of the Curator of the Museum of Comparative Zoology at Harvard College has just come to hand. It is impossible to scan its pages without feelings of sadness and of admiration. For the last time in his official capacity as Director, Prof. Alexander Agassiz, the worthy son of an illustrious sire, renders account of his stewardship. This alone would make for sadness were it not lightened

by the knowledge that resignation was not intended to mean retirement from active research. On the contrary, as was announced some time ago, Prof. Agassiz has taken this step in order to devote his energies and talents, not to speak of means, to the pursuit of zoological investigation in distant and difficult fields. Zoologists must congratulate him on this resolution, deeply as they regret the severance of his official connection with the world-renowed museum which he has been so largely instrumental in creating. For all time the Museum of Comparative Zoology will be a noble monument to the name of Agassiz. But the parting act and the parting gift! These, indeed, command our admiration. As we read the deed of gift, its pathos and nobility seems to us indeed worthy of an Agassiz:—"I, Alexander Agassiz, of Cambridge, in consideration of one dollar and other valuable considerations to me, paid by the President and Fellows of Harvard College, the receipt whereof is hereby acknowledged, do hereby give, grant, and convey to the said President and Fellows the following described articles of personal property now belonging to me, and contained in or used in connection with the Museum of Comparative Zoology."

There then follows in the space of half a page a list of most of the contents of this museum and teaching institution.

The "valuable considerations" chiefly relate to permission being granted to Prof. Agassiz and his private assistants to use certain rooms of the museum for purposes of research, and as a storing-place for—later on to be made the permanent home of—his future collections. Many of us who have come in contact with Prof. Agassiz have experienced his liberality and self-sacrifice for the cause of science. What greater praise of this, his most recent act, can one give than this, that it is worthy of the man?

Mosquitoes.

THE alleged connection between Mosquitoes and Malaria has led to a special interest in the collection of various forms of Culicidae, and in this matter the authorities of the British Museum have printed a seven page tract of instructions how to collect. The chief points in the collection of Culicidae to be borne in mind are, not to use spirit, to pin specimens directly they have been killed, and to send specimens home as soon as possible, because they are liable to go mouldy if kept after death in tropical countries. One of the chief objects of this investigation is the determination of the various kinds of Mosquitoes, since the species belonging to the family are at present but little known. The tract, which applies to all species of Diptera, can be obtained by application to the Director of the British Museum (Natural History), London, S.W.

The Hull Club Commences Author.

THE Hull Scientific and Field Naturalists' Club is one of those local societies to whose energy, directed as it is into the most appropriate channels, we have often had pleasure in alluding. Therefore, although we are accustomed to deprecate the multiplication of minor publications in natural history, we are half inclined to welcome the appearance of the first of a series of annual *Transactions* which the committee has decided to issue. Indeed, our welcome becomes almost whole-hearted when we read that the aim is "to publish original papers and notes of *local* interest." For in these matters it is just those accurately-made local observations that have an abiding value for naturalists at large, whereas the general, even cosmical, lucubrations that fill up some publications of the kind are of interest chiefly, if not solely, to the writers themselves.

The contents of the present number coincide to such an extent with the aspirations of the founders that our welcome becomes actually a warm one. We entertain no doubt that these *Transactions*, if they continue as they have begun, will materially advance the scientific study of natural history in Hull and its neighbourhood. The first paper is by Thomas Bunker, on "The Natural History of Goole Moor and the Immediate Vicinity"; this is historico-pastoral, botanico-ornithological, zoologico-economical, and shows that the marshland of Goole and Thorne Moor is a happy hunting-ground for many kinds of naturalists. H. M. Foster gives a useful and interesting account of "The Fishes of the River Hull," which are of twenty-one species. An exceptionally fine pair of antlers of the red deer (*Cervus elaphus*), from the peat at Hornsea, is illustrated and described by T. Sheppard.

Extracts from the Secretary's Report are published, and from these we learn that the Club now numbers 127 members. Several of them are country members, residing more than ten miles from Hull, and admitted at a reduced fee. A good scheme recently carried out by the Club consists in practical demonstrations on such subjects as taxidermy, microscope preparations, preservation of larvae, and local fossils. J. F. Robinson, the recorder for botany, has compiled a Flora of the East Riding; while the entomologists have in preparation a list of the Macrolepidoptera collected within eight miles of Hull. These will be published in future numbers of the *Transactions*.

The present number is, correctly considered, a quarto, but measures 22×14 centimetres ($8\frac{1}{2} \times 5\frac{1}{2}$ inches). It contains viii. + 28 pages, and one plate. The date of publication, December 14, 1898, is printed on the wrapper; if it were also on the last page it would be still better. The price to non-members is 1s. We congratulate the anonymous editor on the general appearance of the number; at the same time, we would suggest that each annual issue should form an independent part, with fresh pagination.

Stone Implements from Swaziland.

A FINE series of stone implements has recently been sent to England by Mr. Sidney Ryan. They were found near Darkton, in the tin-bearing gravels of the M'Babaan, or Embabaan, River, West Swaziland. The thirteen consists of siliceous schist, black fine-grained quartzite or chert, and of quartzites composed of grit and breccia of quartz, lydite, and jasper. There is also one of crystalline quartz. The large forms vary in length from $4\frac{3}{4} \times 3\frac{1}{4}$ to $8 \times 4\frac{1}{2}$ in., and weigh from $13\frac{3}{4}$ oz. up to 2 lb. $7\frac{1}{2}$ oz. Their shape corresponds to weapons found in England and France, being of a long-ovate, sharper at one end than at the other. Professor Rupert Jones has described and figured these interesting implements in the *Journal of the Anthropological Institute*, New Series, vol. i. It is not possible at present to assign any age to these implements, as the age of the gravel in which they were found has not yet been determined by geologists.

Danish Boulders.

THE investigation of the age of the boulders, as determining the existence of rocks intermediate in age between the Senionian of Jutland and the Lower Palaeozoic of Norway and Sweden, was first begun by Forchhammer about 1820. Of recent years Miss Ethel G. Skeat, of Cambridge, and Mr. Victor Madsen, of Copenhagen, have undertaken the investigation, and the results of their labours are now before us under the title of "On Jurassic, Neocomian, and Gault Boulders found in Denmark." The paper, which forms Part 8 of the second volume of *Danmarks Geologiske Undersogelse*, consists of 214 pages, 8 plates, and a map. Forty-three boulders have been examined, and their fossil contents carefully described by the authors. They have been determined as follows:—11 from the Lias, 1 from the Callovian, 24 from the Kimeridge-Portland series, 2 from the Neocomian, and 4 from the Gault. The general conclusion supports Forchhammer's theory, and the boulders are considered evidence of former deposits to the north of Jutland and in the Skager Rack region.

Coccospheres and Rhabdospheres.

THE nature of these bodies has been referred to in *Natural Science* from time to time, and we now have to record the appearance of the results of researches by Messrs. G. R. Murray and V. H. Blackman during a voyage to the West Indies in 1897. The authors agree with Haeckel

in regarding these bodies as Algae, but consider that all Coccospheres belong to one genus only, the same applying equally to the Rhabdospheres. Both are now described as "free unicellular algae, provided with an outer covering of calcareous plates, free from, overlapping, or readily separable from each other, the plates characterised by symmetrical excrescences or markings." Both are referred to the family Coccosphaeraceae, the Coccospheres being divided into two species—*C. pelagica*, Wallich, and *C. leptopora*, n.sp.; while the Rhabdospheres form *R. tubifera*, n.sp., and *R. claviger*, n.sp. Some beautiful figures by Mr. Highley accompany the paper, which is published in the *Philosophical Transactions of the Royal Society*, volume 190B.

No Freaks.

IT is recorded in the daily press, whether accurately or otherwise concerns us little, that the divergent members of Barnum and Bailey's recently held a meeting, and drew up a memorial protesting against being called freaks. There are discontinuous variations among them, and some strange modifications, but no freaks. It is interesting to find that Dr. Hans Gadow of Cambridge has also been saying "no freaks." The original slight change in pigmentation which started the greenness of the tree-frog is not a spontaneous freak, as the Neo-Darwinians say; it was caused, Dr. Gadow assures us, by the direct influence of the sunlight. But no experimental evidence of this is given.

It seems late in the day to point out, as the author does, that there is nothing spontaneous in the sense of being causeless; or to emphasise against the Neo-Darwinians the universally recognised truism that environmental stimuli must be antecedents of all variations. But as the Neo-Darwinians include in their ranks not a few believers in definite variation — see even Weismann's "Germinal Selection,"—we rather resent being told that we must choose between believing in the inheritance of modifications, which we should gladly do if we could find evidence, and believing that the raw material of evolution may be summed up in the word freaks.

Dr. Gadow maintains that variations are as such adaptive, that variation and adaptation are fundamentally the same—an interesting antithesis to the equally extreme position of Virchow, that all variations are pathological. The author reproaches the Neo-Darwinians for simply taking variations for granted, as if there had not been many attempts (in Cambridge and elsewhere) to find out something about their occurrence, their nature, and their possible origin. And the strange thing is, that after making this reproach, he himself goes one better in postulation, for he begs the question, as it seems to us, by assuming adaptation as a cause, and not a result.

More Misunderstandings of Weismann's Position.

IT seems as if we should do well to stereotype this heading. For the name of these misunderstandings is indeed legion, though Weismann's position is as clear as sunlight. In Haeckel's little book, entitled "The Lost Link," Dr. Hans Gadow returns to the charge against those who find themselves unable to discover any evidence of modification-inheritance. In his notes, which form almost half of the book, and no small part of its interest, the erudite morphologist of Cambridge champions Lamarckism. "The inheritance of acquired characters becomes very obvious," we read, "in the following example"; and being most open to conviction we hurry on breathlessly, to find that the offspring of *Protomyxa aurantiaca* (one of the simplest of the Myxomycetes, or slime-organisms) is as orange as its parent. Does Dr. Gadow really believe that this "example" has any bearing whatever on the problem at issue? Why not also cite the case of the orange-tree? There is no evidence that the orange colour is an acquired character, and it is only with great difficulty that the conception can be applied to any unicellular organisms, where the distinction between soma and germ-plasm is only incipient.

Variation in Sea-Anemones.

IN continuation of our note in last number (p. 12) on variation in a sea-anemone (*Metridium marginatum*), it is of interest to record Mr. H. B. Torrey's observations (*Proc. California Ac. Sci.*, 1898, i. pp. 345-360, 1 pl.) on *M. fimbriatum*, which is "practically identical" with the first-named species. Among 1971 specimens collected at random 48 showed asexual reproduction (monogenesis), some being at the same time sexually mature. Three modes occur—longitudinal fission, basal fragmentation, and budding from oesophageal and foot regions. Parker's suggestion that the monoglyphic and diglyphic types of *Metridium* may be of the value of varieties, "the products one of the sexual, the other of the asexual mode of reproduction," is not corroborated, for both types reproduce by fission, and both may result from fission. Indeed, of two buds which arose independently from a single basal fragment, one was monoglyphic, the other diglyphic. The variants are not varieties.

ORIGINAL COMMUNICATIONS.

On the Study of Plant Associations.

By Robert Smith, B.Sc.

It has long been recognised that a close connection exists between the kind of vegetation of a country and the prevailing conditions of climate and soil, and that changes in the one, either in space or in time (phenology), bring about corresponding changes in the other. Thus many works on the flora of a region have been supplemented by a general account of the conspicuous vegetation in the landscape, the chief trees, the nature of the stations, etc., correlating this with the general climatic conditions of the region. This general account, at first vague and unmethodical, has gradually become more and more organised into a definite survey of the "Vegetation," as contrasted with the "Flora." For long it remained hardly more than a branch of descriptive geography, employed as indicative of the climate and economic wealth of a country, but within recent years the subject has assumed an important biological position, and now may be taken to represent a description of the relations which exist between the plant-covering of a region and the conditions of life.

The floristic method of study, on the one hand, is more directly concerned with the historical development of the "flora." It attempts to answer the questions, How have these species originated? or whence have they come? It studies phylogeny and migration; and the botanical characters to which it directs attention are those on which we chiefly rely for indications of racial affinity, namely, those of the floral organs.

In considering the "vegetation," on the other hand, the essential characters of the species are those indicating adaptation to the environment, and are to be found mainly in the vegetative organs. Hence groups of similar adaptational form, "Lebensform" of German authors, need by no means coincide with natural families or groups of species. For example, *Empetrum* and *Erica*, or *Aloe* and *Agave*, possess similar "life-forms," and could be grouped as Ericoid-forms and Aloe-forms

respectively, yet their floral characters indicate widely separate genetic affinities.

Warming (1896) has recently subdivided the study of Plant Geography into two main branches based upon these two different points of view, flora and vegetation :—

(1) Floristic Plant Geography, which considers questions relating to origin, to past and present lines of migration—in short, to the distribution, past and present, of the species ;

(2) Oecological Plant Geography, which considers the life-forms of species, their association, and their relations to the life-conditions (heat, light, moisture, food, etc.).

The vegetation of any region is to be considered then as an association of plants bound together by the fact that they are all adapted to life in this region. The region may not be uniform throughout its whole area, but may include a great number of sub-associations, each characterised by certain forms of vegetation and determined by particular conditions of life.

Within each association there are various grades of successful adaptation, and accordingly we find that the plants group themselves as dominant, secondary, and isolated species.

The study of the vegetation has thus become a study of plant associations—the life-forms which constitute them, the conditions which determine them, and the relations between them.

The methods for this study are at present by no means well-defined, and probably from the nature of the subject will always remain more or less arbitrary. The differences in the methods employed by the various workers are largely due to the different standpoints from which they view the subject ; whether they regard the vegetation as a term in the description of the scenery, as an index to the meteorological and soil conditions of the country, or as an association of living organisms. This last aspect is the true biological one, and has steadily gained ground within recent years.

The first attempt to organise the study of "vegetation" was made by Humboldt in 1806. Before his time travellers had employed the dominant features of vegetation in describing the landscapes they had viewed. Humboldt tried to make these descriptions systematic. From the experience he gained in his wide travels he enumerated the following plant-forms as dominant in different landscapes :—palm, banana, cactus, orchid, mallow, bamboo, mimosa, aloe, grass, fern, lily, willow, myrtle, melastoma, and laurel. He further noted the variations in the proportions of the individuals of different species, how some were social and some isolated (1807, p. 15) ; and in his definition of the scope of plant geography he says, "C'est cette science qui considère les végétaux sous les rapports de leur association locale dans les différens

climats" (1807, p. 14). In his classical essay (1807), where he treats of the vegetation of Chimborazo, he shows how the differences in the plant-life at different elevations are dependent upon corresponding differences in temperature, humidity, barometric pressure, etc.

A. Pyr. de Candolle (1820) recognised the importance of noting all these facts of association. In his scheme for a flora of the valley of the Lake of Geneva he indicates the following amongst the facts which should be ascertained:—

"5°, La station, c'est-à-dire, la nature spéciale des localités relativement à la nature du sol, à son inclinaison, à son arrosement; la nature et la température des eaux; l'éclairement ou l'obscurité, etc.

6°, Ses variétés locales, c'est-à-dire, les changemens de formes observées dans les limites adoptées et leurs rapports s'il en est avec les localités.

8°, L'indication du degré de sa rareté ou de son abondance, le rôle qu'elle joue comme support, appui, ou ennemi des autres végétaux, la désignation de la plante comme éparse ou sociale; enfin, l'indication des espèces avec lesquelles elle a coutume à vivre."

This attempt to include all the observations on the distribution of the species in a flora has, so far as we know, not been carried out, since it was soon recognised, that many of the facts could from their nature be more conveniently recorded and studied apart from the "flora."

Grisebach (1838) more fully organised the methods for describing the physiognomy of the landscape, and for this purpose introduced the new term "pflanzengeographische Formation." A plant "formation," according to him, is a group of plants, such as a wood or a meadow, which forms a distinct and complete feature of the landscape. It may be characterised by one social species (a pine wood), by a group of similar social species (a pasture), or by an aggregate of species of manifold organisation, but having one general and conspicuous characteristic (an alpine meadow where all the plants are perennial herbs).

Thurmann (1849, p. 22) distinguishes between the flora and the vegetation of a country; after discussing the scope of each method of study he sums up as follows: "La Flore s'entend surtout du nombre des formes végétales distinctes qu'on y observe, la Végetation de leurs proportions et de leur association." He and other contemporaneous students of the relations between the plants and the subjacent soil (such as Unger, von Mohl, Sendtner, etc.) were well aware of the fact that slight differences in the soil conditions give corresponding differences in the frequency of the species growing there, and they employed a series of terms from social to isolated to indicate this.

Alph. de Candolle (1855) attempted to answer the question why some species are social and others not. This, according to him, is due to two causes:—

(1) The constitution of each species, some being able to crush out their neighbours in virtue of certain characteristics such as rapid growth, long duration, quick germination, shade, etc.

(2) The particular conditions of each station. He remarks, too, how many species have the social habit, even to the limits of their area of distribution, where they disappear suddenly and new forms take their place. He reasons that purely local causes seem to be of much more importance than general climatic conditions in determining the abundance of the individuals of a species at any particular point. It is owing to this fact that the study of social species is valuable in topographical botany. He also calls attention, as Humboldt had done before, to the difference between such a case as that of a northern pine forest, where one species is dominant, even to the exclusion of others, and such a case as a tropical forest, where a certain normal character is given by a mixture of many associated species.

Thus the scope of the subject had been foreseen and discussed by the middle of the century, but as yet its interest was almost purely geographical, and the biological element was hardly touched upon.

With Darwin a new period in natural science began. He directed attention upon organisms in nature, how they are adapted to their life, and how they struggle for existence. Since 1859 a steady stream of works have appeared treating of the anatomical and physiological characters of plants in relation to their habitat. In the bibliography at the end of this paper a few only of the chief of these have been mentioned as representative oecological works, dealing with such marked forms of vegetation as strand plants, aquatic plants, halophytes, desert plants, etc. (see List B). Such close associations as exist between symbions, and between parasites, epiphytes, and climbing plants and their hosts, have already an extensive literature devoted to them. The associations of plants and animals, especially plants and insects, have occupied the time of many investigators, even to the neglect of the more general study of plant association.

The first to apply the new ideas to the description of the vegetation of a particular region was Kerner (1863) in his work on the plant-life of the basin of the Danube. After describing the general characters of the region, he represents the vegetation as being made up of a number of "formations" (as defined by Grisebach), each "formation" characterised by some definite species (one or more), possessing adaptations which enable it to suit the particular conditions of environment and to dominate in the landscape. Thus the first steps of the method were :—

(1) To describe the general characters of vegetation.
(2) To enumerate the leading plant "formations" of the region and the plants which dominate in each.

(3) To describe the life-conditions of each "formation," and the forms of vegetation characteristic of it,—whether trees (with evergreen, needle-shaped, or deciduous leaves), shrubs, grasses, herbs (perennial or annual), thallophytes, etc.

Grisebach (1872) brought out his great work "Die Vegetation der Erde," in which he employs the same methods for the description of the plant-life of the whole globe. For this purpose he drew up a scheme of 54 plant-forms to indicate the characters of vegetation of each "formation." His classification was still on the whole geographical, for his "formations" were defined as subdivisions of the landscape ("pflanzengeographische Gliederungen der Landschaft"), and his "forms" as the adaptational forms of plant-life most conspicuous in the landscape.

Reiter (1885) modified Grisebach's scheme of plant-forms to reconcile it with later research in plant oecology. But all such classifications must remain more or less artificial, until we understand more about the nature of these "adaptations." Experimental and histological work on the subject, like that of Vesque, etc. (see List B), must be the basis upon which a true classification can be raised.

Drude (1888) introduced the terms now usually employed to indicate the relative frequency of species in a plant "formation." The term "social" is applied to the dominant species, whose individuals are so numerous that they seem to cover the whole of the ground, *e.g.* the heather on a moor. "Gregarious" plants are those which live in groups or patches in a "formation," *e.g. Anemone nemorosa* in a wood. The other terms "copiously intermixed," "sparsely intermixed," and "solitary" explain themselves. Pound and Clements (1898) point out how often the eye may be deceived with regard to the relative value of the secondary species of a "formation," and they advocate the actual counting of the individual plants within type plots. Blomqvist (1879) for a similar purpose has attempted a graphic method of representing the secondary species in a formation, by mapping typical small areas on a large scale.

Thus methods were becoming well-organised, and several important applications of them had been attempted,—in this connection "Das Pflanzenleben der Schweiz" (1879), by Dr. Christ should especially be noted.

But the term "formation" was found to be insufficiently defined, and it came to have a different meaning with different authors. The "formations" described as units by Grisebach (1872 and 1875) were split up into finer and finer divisions according to the minuteness of the study given to them. Thus Hult (1881) has described almost fifty for Finland alone. To distinguish them he employed a system of nomenclature which is now frequently adopted, where each "formation" is called after the dominant species with the termination

-etum, e.g. Callunetum, Pinetum, etc. Celakovsky (1869) called by the same term, "formation," groups of species of similar habit, station, and distribution, which could be regarded as having migrated together into the country; he thus gave the word "formation" a meaning in floristic plant geography. Drude (1889) attempted to compromise by distinguishing the smaller "formations" as "Bestände," and Weber (1892) similarly classified them as primary and secondary "formations." The original definition of the term by Grisebach as a division of the landscape had lost its force from the newer biological way of regarding the "formation." It was now no longer strictly comparable to a geological formation, and could only in an indirect way be regarded as something "formed."

From the nature of the object sharp definition is impossible. Warming (1896) has recommended the disuse of the term; in its wide sense he says that its meaning can be quite well expressed by the word "Vegetation," and for groups of plants associated together by common habits he employs the term "Pflanzenverein" (in Danish "Plantesamfund"). In English we have named these unions or communities "Plant Associations," as expressing the nature of the relationship of the plants to each other. This expression is employed in a similar sense in papers by Flahault (1897 a), Schroeter (1894), Schneider (1897), etc.[1]

An association may be as narrow as that between two symbions, or as wide as the entire vegetation of the globe. In the description of the vegetation of any region it depends entirely upon how detailed a survey is intended, how many associations it may be subdivided into; if only a general survey, then only the chief and conspicuous associations in the landscape may be treated of, if a complete survey, then all down to the very smallest subdivisions await research. The complete knowledge of the "Vegetation" of any country demands such a complete survey. The methods organised for the study of "formations" apply equally well to "associations," since the "formations" selected are always particular instances of association.

These methods for the description of the "Vegetation" of a country can now be summarised. We require to know:—

(*a*) The chief associations into which it may be divided.
(*b*) The particular conditions of heat, light, moisture, and food distinguishing each association.
(*c*) The particular adaptations or life-forms of the species of each association.
(*d*) The relations between the species—
(1) Dominant social forms.

[1] One must point out, however, that the word "Pflanzenassociation" has sometimes been used by Loew (1879), Höck (1895), and some other authors with a special meaning in floristic plant geography, similar to the application of the term "formation" by Celakovsky as mentioned above.

(2) Secondary social forms struggling for dominance.

(3) Dependent species—simply protected by the presence of the dominant species, or living upon the humus they form, or parasitic upon them, etc.

(*e*) The influence of animals and of man upon *c* and *d*.

(*f*) The general conditions of climate and of vegetation of the region compared with other regions.

A concrete example of a brief survey of a type region will illustrate the application of these methods.[1] For this purpose I have chosen such an area as may be found in many places round the coast of Britain, namely, a stretch of sand dunes and links, the present example being from the Ayrshire coast, between Prestwick and Troon.

The small associations are numerous, but I select only the more important for the purposes of illustration. These are the strand plants, the dune bents, the grassy links, the heathy knolls, and the pine woods. If expressed in terms of the most important species of each, these would be respectively the associations dominated by *Atriplex*, *Ammophila*, *Agrostis*, *Calluna*, and *Pinus*.

The strand plants (*Atriplex*, *Cakile*, *Salsola*) are on loose shifting sand, occasionally submerged by spring-tides, and beaten upon by the wind. They are all annuals (cp. the great proportion of annuals to be found on the regularly overturned earth of cultivated land); recumbent in habit, thus spreading over the loose sand, holding it together and escaping the full force of the wind; succulent, an adaptation connected with presence of much salt; and their surfaces are reduced in extent or otherwise modified to prevent excessive transpiration. On the strand competition between the species is almost absent, for so few can live at all in these conditions that each plant has a free space of ground to itself. Human influence has not appreciably modified the conditions.

The dunes are beyond the reach of the waves, but are exposed to the fury of the wind, to drought, and to the moving of the sand. The dune plants are adapted in various ways to withstand excessive transpiration. Some are also salt-loving species, such as *Ammophila*, *Elymus*, *Agropyron junceum*, *Eryngium maritimum*, *Arenaria peploides*, *Volvulus Soldanella*, etc. The dominant and by far the most abundant species is *Ammophila arenaria*, which grows in great tussocks, holding the sand together, and sheltering from the full force of the wind numerous more delicate species that occur sparsely distributed on the dunes. The conditions are still too hard to allow a large flora, and competition between the species is almost at its minimum. Except

[1] For the present purpose, as will be clear, we are not concerned with how the plants came into this region, but with how they live there. The study of the immigrations of the British Flora has such an interest from its complex and striking nature that it has long attracted students. It is partly due to this that the oecological standpoint we are now assuming has received comparatively little attention.

in so far that a number of the casual plants in this association are weeds of cultivation, man has not modified it much.

The grassy links are on low-lying, more sheltered, and better irrigated parts, but still exposed to the sweep of the winds. The grasses (*Agrostis, Aira,* etc.) and herbs inhabiting the ground are perennials—low-growing, turf-forming, wiry species. Competition between the members is very severe, and very few plants can fight their way through the close turf which covers the ground. Sheep are pastured on the links, and rabbits in abundance nibble there. Only such species can exist that withstand this continual cropping. The manure from the animals enriches the soil, and here and there enables finer species of grass, clover, etc., to enter.

The association of *Calluna* is especially found on the dry, mossy knolls, where variations of water-supply must be considerable. The adaptations of *Calluna, Erica,* etc., to these severe conditions of life are well known.[1] This association is not particularly well developed upon the Ayrshire links compared with other similar stations where the association is protected and increased by being regularly burned by man. The immediate effect of burning is usually to allow a growth of grasses, *Vaccinium Myrtillus,* or other plants — secondary social species, which for a while dominate—but later the young heather comes up and peoples the area more fully than before.

The pine wood may be regarded as the natural arborescent vegetation of the fixed dunes or links, although here the present woods have certainly been planted by man. But if grazing animals are excluded, seedlings spring up naturally—as can be seen in some parts of those woods—so that when the wood becomes old, its vegetation is essentially that of a naturally-sown wood. Its situation includes ground similar to the grassy links and to the heathy knolls, and since these particular woods are fairly well lit, the subordinate vegetation is in part similar to that of these exposed stations. The pine association is complicated in its constitution. Sub-associations, dominated over by *Betula, Rubus, Ulex, Calluna,* various grasses, etc., occur in its clearings or under its canopy, according to the differences in degree of moisture, shade, or humus. Quite a hierarchy of forms can be grouped as constituting this association:—trees, shrubs, herbs, mosses, and thallophytes—each forming a different layer of vegetation. Certain forms characteristic of woods are present:—saprophytes and shade plants (*Goodyera repens*); climbing plants (*Lonicera periclymenum*); epiphytes (lichens and occasionally *Polypodium vulgare*), etc.

The classification of plant associations has recently been carefully considered by Warming (1896). He points out how the state of

[1] See Professor L. C. Miall, "A Yorkshire Moor," *Nature,* vol. lviii., August 1898, pp. 377-380 and 401-404.

moisture is on the whole the most important condition in determining any particular association, and he employs this as the chief basis of his classification. He groups the plant associations as follows:—

Hydrophyte vegetation.—This requires a substratum with at least 80 per cent of water. It includes associations of aquatic and marsh plants.

Xerophyte vegetation.—This is the opposite extreme from the previous class, requiring less than 10 per cent of water. It includes associations of rock, desert, moor plants, etc.

Halophyte vegetation.—Also an extreme vegetation, allied in many of its adaptations and habits to the Xerophyte vegetation, but characterised by requiring the presence of much salt, for instance the strand and the dune associations.

Mesophyte vegetation.—An intermediate class adapted to medium conditions of moisture, and not requiring a special amount of salt, for instance the associations of beech and oak woods.

For further subdivisions of these four classes we refer to Warming's original work.

In employing this classification it is essential to remember that variation in humidity is not the only acting condition,—the species are very differently adapted for the struggle with each other, even if the acting conditions are uniform; the nature of the food supply in the soil varies from place to place, and each variation may more or less affect the association; local conditions of light and shade, *e.g.* in the woods, modify the minor grouping of the species; and further, all the species are dependent upon the wider conditions of light and of temperature of the particular region of the globe. A similar physiological method of grouping plants to this of Warming was suggested by Alphonse de Candolle (1874), based upon the combined conditions of heat and moisture. Its application to the graphic representation of the vegetation of the globe will be seen in maps by Engler (1879) and Drude (1887).

The methods for the detailed mapping of the vegetation of a country have recently been greatly advanced by the labours of Professor Flahault of Montpellier (1897 b), who has shown the possibility of a very exact botanical survey, applicable to the consideration of questions of botanical geography, meteorology, geology, forestry, and agriculture. Briefly stated, the method consists in recording, by means of a large-scale contour map, the exact range over the country of certain representative plant associations. The selected associations are naturally as large and well defined as can be found; in this case, where Southern France has been studied, the dominant trees have

been chosen. Already a large district has been surveyed, and in 1897 the first sheet was published. It is the region of the Eastern Pyrenees, and shows clearly the areas in which the following trees respectively dominate:—evergreen oak, cork oak, ordinary oak, chestnut, beech, maritime pine, Austrian pine, Scots pine, silver fir, and mountain pine.

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UNIVERSITY COLLEGE, DUNDEE.

Mimetic Resemblances in Animals and Plants.

By Rev. Prof. George Henslow, M.A.

Insufficiency of Natural Selection.

Mimetic resemblances in animals, either to others or to objects in their natural environments, are mostly regarded as protective; and this feature of protection has been assumed to be their rationale, or, in a sense, the "cause" of their existence. Darwinians assume that the animals which resemble their neighbours, by possessing a similar coloration and by adopting similar habits, are the result of the survival of the fittest, all others insufficiently resembling the protectors, *i.e.* all "unfavourable variations," having been killed off by natural selection.

Thus, Professor E. B. Poulton has lately published a paper on "Natural Selection, the Cause of Mimetic Resemblances and Common Warning Colours";[1] but in no part of it does he explain how natural selection can be "a cause." If he use the term metaphorically, it is misleading, for the other hypotheses mentioned in the paper do profess to supply actual physical causes, viz. "the direct effect" of the external conditions of life, or an "internal developmental cause." Natural selection is not "a cause" in any physical sense whatever. It only means, according to Darwin, "the preservation of favourable individual differences and variations, and the destruction of those which are injurious. This (he says) I have called Natural Selection, or the Survival of the Fittest."[2] On several occasions Professor Poulton discards all other hypotheses, and says, "Under the theory of natural selection the facts at once receive an explanation." Undoubtedly they may; *if only* its supposed powers were true and not imaginary. Natural Selection seems not unlike the wand of the fairy, which could evolve a coach and six out of a pumpkin and mice. But, in fact, all that it can tell us is, that some beings live and others die. It can neither account for the physical cause of a useful variation in one organism, nor say why another organism dies. It only, so to say, registers the fact.

[1] *Journ. Lin. Soc.* (Zool.) xxvi. 1898, p. 558.
[2] "Origin of Species," p. 63.

What, however, I wish to call attention to is, that mimetic resemblances cover a far wider field than that occupied by protective resemblances among insects. In fact, it is equally common in the vegetable kingdom, as it probably is in all classes of animals.

Protection not always associated with Mimicry.

Protection is no doubt a benefit, but it does not appear to be always associated with mimicry. It is questionable how far the effect is useful when all the animals of a district are coloured alike, as in a sandy desert; for not only are the carnivorous animals tawny coloured, but so are their prey, as may be seen in the collection in the entrance hall of the British Museum (Natural History Department), to which might be added a spider and *Helix desertorum* noticed by the present writer near Cairo.

It would seem more probable that there has been some general cause in the physical environment. The monochromatic light suggests itself as a cause acting upon all the creatures alike which are subjected to it; and if the result prove to be advantageous, so much the better for the creatures. That this is the right direction to look for a solution of such mimicry as superficial colouring, appears to be evident from the case of the house-mouse, which Mr. H. Lyster Jameson has described.[1] This author also speaks of "natural selection . . . weeding out unfavourable variations," but he does not appear to have met with any actual cases. He gives a list of thirty-six mice examined, but they range from the common domestic form to the palest-coloured of all. The variations, according to his description, are all in one direction towards a rufous or fulvous gray. In fact, they form a graduated series, but there is no mention of injurious varieties; indeed, after about one hundred years there are still some 14 per cent of the ordinary mouse-coloured forms still extant. And as the island is fully stocked (a female can give rise to nine at a birth), it is obvious that the sandy-coloured mice are as easily killed off as the others. The fact seems to be that as long as an animal coloured like the ground is *at rest* it cannot readily be seen, but when it *moves* there is little difficulty about it.

That natural selection cannot be a universal cause of mimetic coloration is obvious from the fact that some animals change from brown to white in winter, and many change according to the surroundings in which they happen to occur, as in the most familiar case of the chameleon, and a remarkable tick described by Sir J. D. Hooker, who says, speaking of a lizard—"Its throat was mottled with scales of brown and yellow. Three ticks had fastened on it, each of a size covering three or four scales: the first was yellow, corresponding

[1] "On a Probable Case of Protective Coloration in the House-Mouse (*Mus musculus*, L.)," *Journ. Linn. Soc.* (Zool.) xxvi. 1898, p. 465.

with the yellow colour of the animal's belly, where it lodged; the second brown, from the lizard's head; but the third, which was clinging to the parti-coloured scales of the neck, had its body parti-coloured, the hues corresponding with the individual scales which they covered. The adaptation of the two first specimens in colour to the parts to which they adhered is sufficiently remarkable, but the third case was most extraordinary."[1]

Without explaining how "the trick is done," the word "adaptation" seems best serviceable, both for mimetic coloration and mimetic forms. Thus, taking the Australian marsupials as examples, we have the well-known imitations of placental Mammals occurring among them as a result of similar habits, but certainly not of protection arising from similarity. Thus, Andrew Murray observes how "*Antechinus minutissimus*, the kangaroo mouse, closely mimics *Mus delicatulus*; the flying Marsupial *Petaurus* is a close counterpart in outward appearance of some of the flying squirrels. One or two of the *Phascogales* or *Antechini* resemble the jerboa; *Peragalea lagotis* has considerable resemblance to a hare, and carries its habits as well as its ears, making a form in the grass like it."[2]

That similar usages have educed similar structures, without affinity, is seen in cases where only certain parts of animals are mimetic. Thus the paddle of a whale resembles that of the *Ichthyosaurus*, and its tail that of a homocercal fish-tail, though it lies in a horizontal plane instead of a vertical one. Such resemblances are too numerous to mention; but there is no question of protective resemblances or of natural selection in the matter.

Inductive evidence of this kind brings us to the inevitable conclusion, not only that like causes have produced similar results, but that they are the direct outcome of the joint action of the outward physical conditions of life and the inward adaptive powers of protoplasm, coupled with the habits of life. Beyond that we do not seem capable of going.

Mimicry in Plants.

Objections have been raised as to the applicability of the term "mimicry" to animals, and so *a fortiori* in regard to plants; for the word originally meant an actual imitation by a human being in gesture and manner. It might be conscious as in dumb-show, or unconscious as under delirium.

Now in mimetic insects the mimicry consists in the form and colour resembling others of no affinity, or in being like external objects, as well as in the adoption of similar habits. Thus, in the case of the "stick" insects, it is said that they allow their legs to assume unsymmetrical positions when at rest, so as to resemble a branch with

[1] "Himalayan Journals" (Minerva ed. p. 26).
[2] "The Geographical Distribution of Mammals," p. 53.

twigs more exactly. If so, there is both an unconsciously acquired resemblance in form and a conscious mimicry in action.

If, therefore, mimicry has been thus allowed to have its meaning extended to include a superficial or structural resemblance in animals, often apart from imitation in habit, we are quite justified in applying it to plants, among which such resemblances abound.

In the vegetable kingdom it arises from common causes and issues in common uses.

Mimetic resemblances are particularly characteristic of plants growing in very specialised environments, such as under water; in high alpine, arctic, or antarctic regions; in deserts and arid countries, etc.; as well as of plants which are highly specialised for carrying on certain peculiar functions, as of insectivorous, climbing, parasitic plants, etc.

In all these the same functions have resulted respectively in producing similar structures. In other words, whether one studies the external mimetic morphology or internal anatomy, the conclusion appears to be inevitable that these imitative features are simply due to the direct action of the environment, together with the responsive powers of protoplasm; though one cannot explain how the process is effected.

Aquatic Types.—Commencing with submerged leaves, the type of foliage most common in dicotyledons is finely dissected, though as soon as the stem reaches the surface of the water it may develop more or less lobed or entire leaves, as may be seen in *Ranunculus heterophyllus* and the water-lily.

Now this type is imitated by many aquatic plants of no affinity, as in *Cabomba* (Nymphaeaceae), *Myriophyllum* (Halorageae), *Hottonia* (Primulaceae), *Apium inundatum* (Umbelliferae), *Ceratophyllum* (Ceratophylleae), etc. Affinity among these plants is quite out of the question; but since the water crowfoot is undoubtedly descended from some terrestrial buttercup, and the Halorageae are aquatic forms of Onagraceae, and *Hottonia* is allied to land primroses, etc., the inductive evidence is ample to prove that this type of submerged foliage is entirely due to the direct and arresting action of the aquatic medium, which brings about degradations throughout the entire plant.

Another type of submerged leaf is ribbon-like. This is seen in *Lobelia dortmanni*, *Hippuris*, etc., but it is commoner among monocotyledons. From these, as in *Sagittaria*, we learn that this form is really phyllodinous as long as it is in deep water; but when the surface is reached the leaf develops a blade at the summit. And since a progress from phyllodes to sagittate blades is imitated in Nymphaeaceae, we again see a direct cause and effect.[1]

Juncaceous Type.—A stem with much reduced leaves and a rounded

[1] For fuller details of these and the following types the reader is referred to "The Origin of Plant Structures," Internat. Sci. Series, vol. lxxvii.

rachis, resembling those of a rush, is characteristic of many marsh plants, but is not confined to the genus *Juncus*. Thus *Oenanthe fistulosa* and *Crantzia lineata* (Umbelliferae), several Cassias, *Spartium junceum*, etc. (Leguminosae), *Scorzonera*, *Enhydra* (Compositae), *Convolvulus chondrilloides* (Convolvulaceae), *Johnsonia* and *Sowerbia* (Liliaceae), *Bobartia* and *Lansbergia* (Irideae), are all good illustrations enforcing the same conclusion as to the common origin of their common resemblances.

XEROPHILOUS TYPES.—One of the commonest mimetic features of plants growing in very arid districts is to be spiny. Our own *Genista anglica* (Needle-Furze) and *Ulex europaeus* (the Common Furze) will illustrate it; but "thorns and thistles" have been recognised as typical of deserts from the earliest ages.

That drought is the actual cause of spinescence in all cases has been easily proved by growing such plants in a moist soil and air, when the spinescence rapidly disappears.

Another xerophilous and more remarkable type is the fleshy stem. Thus the Cactaceae of Mexico mimic very closely the Euphorbias with thick leafless stems of the Soudan, as well as the Stapelias (Asclepiadaceae) of South Africa. As the conditions of life in which these three groups live are the same, their peculiar vegetative structures have been similarly evolved.

ALPINE TYPES.—One of the most characteristic types of vegetation is that of the Cypress, *Thuia*, and Juniper, the leaves of which are extremely minute and closely adpressed and imbricated along the slender shoots.

Now, we find this type of foliage exactly paralleled in, or mimicked by Alpine species of the genus *Veronica*, which abound in New Zealand. The species of the lowlands are shrubby, with large leaves; those of a higher elevation begin (say) with *V. buxifolia*, so called because its leaves resemble those of the box; then on ascending to 4000 and 5500 feet there occurs *V. cupressoides*, the specific name indicating its mimetic resemblance to the Cypress; while at 8000 feet *V. lycopodioides* is found, resembling the *Lycopodium*, or Club-Moss.

As drought appears to be one of the direct causes of this diminished type of foliage, it is not surprising to find it mimicked in the African deserts by *Salsola pachoi*, etc. So, too, in the Antarctic regions, it is exactly paralleled by that of *Drapetes muscosa* (Thymelaceae), *Bolax glebaria* (Umbelliferae), *Lyallia kerguellensis* (Caryophylleae), *Forstera glavigera* (Stylideae).

MUSCOIDAL TYPE.—This is one of the extreme forms of high Alpine as well as of Arctic and Antarctic forms. Besides the above-named species of *Veronica*, there are *Saxifraga bryoides*, *S. muscoides*, *Cherleria sedoides*, *Silene acaulis*, etc. Lastly, *Bolax glebaria* (Umbelliferae), of the Falkland Islands, is mimicked by species of *Acanthophyllum* (Caryophylleae), in Afghanistan, and by *Haastia* (Compositae), in New Zealand.

GRASS-LEAVED TYPE.—Herbaceous plants growing thickly together, and so preventing each other from spreading out their blades horizontally, have often assumed a grass-like foliage. Hence a caespitose habit has induced a vertical position in the foliage, so that the leaf has acquired a narrow linear form, the anatomical details following suit by its developing stomata, etc., on both sides. *Lathyrus nissolia*, which grows among grass, has this type of leaf. Thrift, Pinks and Carnations, Sedges and the Bog Asphodel, as well as Grasses, have similarly-formed leaves. Those belonging to dicotyledons retain the reticulated venation, the branches starting from near the base at an acute angle, thus more or less imitating the parallel venation of the monocotyledons.

SPECIALISED MIMETIC ORGANS. — Leafless but foliaceous stems, closely mimicking true leaves, occur in widely-separated orders having no affinity. Thus *Xylophylla* (Euphorbiaceae) may be compared with *Ruscus* (Liliaceae); while of leafless but winged stems the following are good examples:—*Bossioea scolopendria*, *Genista sagittalis*, and species of *Acacia* (Leguminosae).

CLIMBING PLANTS.—Mimicry is well seen among these; as, for example, between the tendrils of a vine or passion-flower, which consist of metamorphosed flowering branches, and those of a pea, which are homologous with a leaf. In *Dissochaeta*, aerial roots undertake the same function, as do the slender branches of species of *Strychnos*.

ASCIDIFORM TYPE.—Perhaps no better illustration of plant mimicry could be given than that between the pitcher of *Cephalotus follicularis* and that of species of *Nepenthes*. These two genera are monotypic, and therefore imply a long and now lost ancestry. The general appearance of the mimetic pitchers is precisely the same in both. There is a similar "lid," a pitcher of the same shape, with an inrolled margin, glands sunk into the surface of the lining of the pitcher, which externally carries a fringed guide from bottom to top. Yet, while the pitcher of *Cephalotus* is a metamorphosed leaf-blade, that of *Nepenthes* is developed out of a water-gland situated at the apex of the blade, this latter taking no part in its formation whatever.

Such complete mimicry as this is quite as astounding as any between two insects, whose forms and colours are alike, or between the kangaroo mouse and the genus *Mus*.

CONCLUSION AS TO MIMETIC VEGETATIVE ORGANS. — The above-mentioned cases are but samples of what may be called a general principle in nature; which is, that since the living protoplasm is of one and the same kind in all beings, as far as we know, where a certain feature is evolved, a similar one may be expected under similar conditions, and a mimetic organ is the result; that is, so far as the conditions of the structure will allow. Thus as the kangaroo mouse mimics a true mouse, but retains its pouch and insectivorous teeth; so a linear dicotyledonous leaf imitates a grass blade, but retains its branching venation.

MIMETIC FLOWERS.—These are by no means uncommon. Bracts are often coloured, and so to say answer for a corolla, as in *Poinsettia*, *Euphorbia*, some Umbelliferae, and "everlastings." But the mimicry may be much more exact, and so close, indeed, as to deceive the unwary. Thus the four white bracts of species of *Cornus* render the inflorescence exactly like a flower of a *Clematis*. *Darwinia tulipifera*, as the name implies, is very like a tulip; while *Euphorbia jacquiniaefora* has five scarlet lobes on the rim of the involucral cup, thereby mimicking a corolla with five petals.

The papilionaceous corolla of the Leguminosae is imitated by the so-called "falsely-papilionaceous" corolla of *Polygala*. It is also seen in the gamopetalous corolla of *Collinsia bicolor* (Scrophularineae), the front petal of which closes over the stamens and pistil precisely as do the keel petals of *Genista* or other member of the Leguminosae. A similarly shaped corolla is seen in some species of *Pelargonium* (Hoarea group). Again, a spike of flowers of an orchid, *Disa cooperi*, is very like one of a larkspur with its upturned and elongated spur.

Lastly, *Crocus* (Irideae), *Sternbergia* (Amaryllideae), and *Colchicum* (Liliaceae) have precisely similar perianths, though representatives of as many orders.

GENERAL CONCLUSION.—When all the above facts (and many more might have been given) are considered together, and when it is noted that in many cases experimental verification shows that the peculiarities in question are the results of the definite or direct action of the environment, the inductive evidence is overwhelming that mimetic results are in all cases the consequence of the environment influencing the protoplasm to adaptive response. It will thus be seen that natural selection is quite uncalled for, and, in fact, has no *raison d'être* in the origin of any structure whatever.

80 HOLLAND PARK, LONDON, W.

Bees and the Origin of Flowers.

By G. W. Bulman, M.A., B.Sc.

Those engaged in the study of the mutual relations of insects and flowers will read with interest a short paper in *Natural Science* for October last on "Bees and the Development of Flowers," by Mr. F. W. Headley, Haileybury College, New Zealand. It is to be feared, however, that this writer's attempt to save the situation for Darwinism as regards the origin of flowers will hardly stand the strain of criticism. Mr. Headley admits that the habits of bees in passing freely from variety to variety, or from one nearly allied species to another, will tend rather to retard than promote the development of new species. "Thus it is just where her constancy might seem most needed," he writes, "that it breaks down. When new varieties are arising, the operation of bees comes in to swamp them, if possible, by intercrossing, and so prevent them from developing into species." This, indeed, must be obvious to all. But while giving up the old explanation, Mr. Headley still thinks the colours of flowers must be explicable on Darwinian principles. "*A priori*," he says, "if it be granted that the Darwinian hypothesis affords a satisfactory explanation of other phenomena of the animal and vegetable worlds, it seems unlikely that it should leave the colours of flowers unexplained." This is doubtless true, and if the origin of species is due to the Darwinian principle of natural selection, then the colours of flowers must be due to the same. To stop the gap, then, caused in the theory of the origin of flowers by insect agency by the loss of the constancy of the bee, Mr. Headley takes a plank from Dr. Romanes' doctrine of physiological selection. The action of the bee, he thinks, in carrying pollen from variety to variety will be of no consequence, since these varieties are sterile *inter se;* while in carrying it from individual to individual of the same species it will still give an advantage to those it visits. As proof of this sterility between varieties of wild-flowers the experiments of the French botanist, Alexis Jordan, quoted by Romanes in "Darwin and after Darwin," vol. iii., are referred to. But even admitting that Jordan proved his case, we have still the following objections to bring forward. If the bee visits indifferently *all* the varieties of a

species it cannot raise one or more of these to the rank of distinct species at the expense of the others, as it ought to do on the principles of natural selection. Again, admitting that all species, sub-species, and varieties as they exist to-day are sterile *inter se*, we cannot suppose that the *varying individuals* in a species—which must form the beginning of a new species—are so. And it is with such that the bee has to deal at the beginning of the development. *Ce n'est que le premier pas qui coûte*, but if you cannot take the first step it does not matter how easy the rest are. Thus the principle of physiological selection will scarcely man the breach caused by the loss of the constancy of the bee. But can we accept fully the principle that varieties are as a rule sterile *inter se?* Dr. Romanes, indeed, seems to have accepted it unreservedly, but it is hard to resist the conviction that had it been less in accordance with his theory of physiological selection he would have subjected the evidence to more rigid criticism. The experiments, we may note, were made some twenty-five years ago, and do not appear to have been since confirmed. They were also avowedly made for the purpose of proving that each species and variety had been specially created. Darwin, moreover, found that crosses between slight varieties were more, and not less, fertile than those between individuals of the same variety. This is also the experience of gardeners and breeders.

With regard to the question of the influence of colour on insects, Mr. Headley writes as follows:—

"To account, then, for the colours of flowers we have the proved colour-sense of bees. Sir John Lubbock has tested it by experiment: they are attracted by brilliant blossoms, and, therefore, it has been to the interest of plants, in order to obtain cross-fertilisation, to produce conspicuous flowers."

But whoever ventures to form an opinion on this very difficult subject will have also to take account of the exhaustive experiments recently carried out by Professor Plateau of Ghent. That gentleman concludes, as the result of his researches, that insects are attracted to flowers in a very subordinate way by sight, and chiefly by another sense, viz. smell. My own observations do not lead me to go so far as to say that the colours of flowers have nothing to do with attracting insects to them. But I do most emphatically assert that they are indifferent as to what particular colour the flower they visit is. As far as I am able to judge, it matters not one iota to a bee whether the flower is blue, red, pink, yellow, white, or green: so long as there is honey, that is sufficient. Indeed, we sometimes hear of bees gathering the honey-dew from the leaves of trees, visiting sugar refineries, and robbing jam factories.

As regards the supposed constancy of bees in visiting flowers Mr. Headley expresses his opinion thus:—

"That they show a remarkable degree of constancy is undeniable.

When at work upon dandelions they will not wander to a neighbouring narcissus. In thus keeping to flowers of the same make, they are consulting their own interest."

Now, while in this and in other parts of his paper Mr. Headley goes farther than is allowed by the advocates of the insect-selection theory, and too far to render that theory tenable, it is still, according to my observations, short of the truth. Thus, while I have never seen a bee go from dandelion to narcissus I have seen them go from dandelion to chickweed, from Iceland poppy to Cistus, from herb Robert to lavender, from snapdragon to woundwort, from devil's-bit scabious to knapweed, etc. The fact, however, that bees pass at times from one very different species to another, while it renders the bee still more impossible as an evolver of flowers on the old view, does not affect Mr. Headley's proposed amendment.

Another point in Mr. Headley's paper seems to call for remark. He asserts that flowers not fertilised by insects "are almost all of them dull and inconspicuous." But there are probably a good many exceptions to this rule. One of these is specially mentioned, viz. the larch, of which it is said, "In these the colour may, possibly, be looked upon as a by-product of the physiological activity of the plant. The more striking blossoms, elaborate in form and coloration, cannot possibly be mere by-products."

But this is no explanation: it might with equal truth and justice be said of the blue of the larkspur, the crimson of the cranesbill, or the yellow of the buttercup. Indeed, in every flower the colour is the product—why in any case call it a by-product?—of the physiological activity of the plant. If the blue of the hyacinth and harebell require a further explanation, so does the red of the larch.

In conclusion, a word as to my own position as regards this question. Mr. Headley remarks that certain naturalists, including myself, "have come to the conclusion that the colours of flowers have arisen quite independently of insects." I should prefer to define my position in slightly different words. Instead of saying I have come to the conclusion that the colours of flowers have arisen quite independently of insects, I should like to put it thus:—

I conclude, as the result of my observations of the habits of insects visiting flowers, that the theory of the origin of the latter by their selective action, as taught by Darwin, Wallace, Hermann Müller, Sir John Lubbock, and Mr. Grant Allen, is absolutely incompatible with the facts of the mutual relations of insects and flowers.

29 QUEEN'S TERRACE, JESMOND,
NEWCASTLE.

Principles of Animal Development.

By JOHN BEARD, D.Sc., *University Lecturer on Comparative Embryology and Vertebrate Morphology, Edinburgh.*

I. *A Whelk's Egg.*

"OMNE vivum ex ovo" is now an ancient aphorism, and it has become a commonplace to say that the starting-point of almost all animal development at the present time is the fertilised egg. The phenomena leading up to this need not concern us at present. Let us assume that we have got our fertilised egg, and let us in the first place consider what sort of a thing it is. If the choice of such an egg be given, how great is the variety out of which it may be selected. It may be the microscopically small egg of an Echinoderm, or one of larger size from the cocoon of an earthworm, the still bigger one from the leathery egg-case of a whelk, or the huge one from the marvellous egg-capsule of a smooth skate. It may be so large and contain so much food-material that the developing organism may feed upon it for two years, or so small and so destitute of nourishing substances that it can suffice for the needs of the development for but a few hours.

It may be destitute of any envelope beyond a thin structureless membrane formed by the egg-cell itself, or it may be closely wrapped up in a series of coverings, and outside of these we may find a shell or case of complex form and architecture.

The eggs of animals are, indeed, endless in variety, when the size, amount of food-yolk, coverings and appendages, and the modes in which they are deposited are taken account of. But with all this one fact stands out quite clearly, that the size, composition, mode of deposition, etc., of any particular egg, have an intimate relation and connection with the development of an individual of the species whose egg it is.

The individual peculiarities of ova raise various interesting questions which have hitherto received but the barest consideration in embryological text-books and even in developmental researches. Probably for solutions of most of them the science will have long to wait. The nature of most modern embryological research is, unfortunately, not such as to furnish hints in the direction of their elucidation;

the amount one man can accomplish, even if he be conscious of the existence and importance of the problems, is but the merest trifle, and his labours would require an enormous comparative material, if the results were to be of far-reaching import.

These reasons, paradoxical though it may seem to be, impel the writer to attempt some sort of consideration of the subject. It might be made the work of a lifetime without evidence of exhaustion of the subject. If we are ever to have a true and real comparative embryology of organisms, as well as the existing comparative embryology of organs, many questions relating to the eggs of animals will need to be cleared up.

Facts are to be found for the seeking; but, as every conscientious embryologist realises, the search nowadays, especially if it be in some definite direction, is often long and arduous. And the result may often be a single fact and a dozen new problems. Moreover, most of us have our plans of work mapped out for years to come, and have no desire to forsake the plot of ground which we have diligently and hopefully tilled, before we have reaped our little harvest. Therefore, since the problem of the individuality of eggs with which we have begun forms no integral part of our personal task, what we have to say under this head partakes rather of the nature of incidental gleanings and musings than of deliberate investigation. We have attempted to enunciate some of the problems without pretending to do more than suggest what may be the nature of some of the solutions.

Examine on the sea-shore the egg-capsules of a dog-whelk (*Purpura lapillus*). If one of the freshly-deposited cases be opened, in its interior a large number of minute eggs may be counted. Some time later visit the same spot and open others belonging to the same bunch. The probability is that the enumeration of the developing organisms in all the egg-cases of the bunch will not give as large a number as that already recorded in the single freshly-deposited one.

This is of course an old story. The cannibalism of the developing young of the dog-whelk and whelk is one of the commonplaces of marine zoology.

Many years ago the writer endeavoured to study it for himself, but as the examination of the cases was begun, when, as it turned out subsequently, the eliminative process was over, it was naturally not observed; although the facts were looked for until the young whelks emerged from their cases. The process on that occasion was not seen, simply because it happens at a very early period. One interesting little point did, however, reveal itself, that the number of young whelks within an egg-case was fairly constant, about five or six. If the process be mere cannibalism, it is not easy to perceive why it should stop short, when some five or six larvae were left in the egg-case, why, as almost always happens in the case of the Alpine *Salamandra atra*, one should not devour the rest.

The number is so constant in the whelk, that one may suspect that it is governed by some law. Probably, too, if one counted them, the number destined to be devoured would be found to be equally constant. The whole process must take place under the workings of a law or laws, and it is part of our task as embryologists to try to find out what these are and what determines them.

If, after the examination of the whelk-cases, a fully-formed egg-purse be taken from the oviduct of a dog-fish or skate, on opening this we shall almost certainly find but a single egg.

The eggs of different species of dog-fish or skate also differ considerably in size, both as regards the egg-cases and the yolks. These differences are not always in relation to the specific differences in size. The smooth skate (*R. batis*) is much larger than the starry ray (*R. radiata*), but no proportion can be detected between the sizes of the two skate and those of their eggs. Indeed, if we study the ripe eggs of two closely allied species of shark, *Mustelus vulgaris* and *M. laevis*, we find that, although the two fishes are almost of identical size and so alike that no fisherman could ever be expected to distinguish between them, their eggs exhibit great differences in size along with almost inappreciable differences in the texture of the egg-capsule.

What, then, are the essential differences between the eggs of these two species? The egg-shell of *M. vulgaris* appears to be rather thicker than that of *M. laevis*, and—a very important point—the actual egg, the yolk, of the former is the equivalent in size and weight of about four of the latter.

This difference cannot be ascribed to the relative sizes of the two species, and, as a matter of fact, it is in association with a very fundamental difference in the mode of development.

Both species are viviparous, and it is possible that the young are born in both cases in the same condition of development, though this has yet to be determined. In *M. vulgaris* the yolk suffices for the whole of the uterine development, whereas in *M. laevis* it is used up long before uterine life is over, and for what is probably a long portion of its uterine existence the young *M. laevis* is nourished by a sort of placental attachment of its yolk-sac to the uterine wall, as recorded by Aristotle, and as rediscovered during the present century by that great embryologist, Johannes Müller.

The instances above mentioned may serve as the text for further study. Modern embryology has never yet seen any difficulties or even any problems in the matter at all. We have our classifications of various kinds of eggs. We recognise eggs with little or no food-yolk, and those with much. Various forms of segmentation or cleavage of the egg are distinguished, such as equal or adequal, unequal but complete, and meroblastic or partial. Our leading text-books either say, or lead the reader to infer, that the differences between the various forms of cleavage are dependent upon the amount

of food-yolk. As compared with the egg of a frog or toad that of a cod-fish contains but little food-yolk, yet the former exhibits unequal but complete cleavage, and the latter partial or meroblastic. Our classification may be convenient for purposes of elementary instruction, but it is purely empirical and has no real scientific basis.

It is like everything else. With the advance of knowledge, our conceptions of organic Nature become enlarged, and we come more and more to perceive how adverse Nature is to schematic and empirical classifications. But within recent years we have gone further still in the use or abuse of food-yolk in embryological science. It has even been made the basis of a phylogenetic tree of vertebrate ancestry. What more could be asked of it than this? The discoverer of this tree has indeed disowned and rejected the figment of his own imagination; but, this notwithstanding, from time to time it tries to blossom forth anew.

If it could be proved that, as we ascend the vertebrate scale, the food-yolk either increased or decreased in a regular and intelligible fashion, good reason might underlie its use in phylogenetic speculation. But if we attempt to evolve dog-fish and skate from lampreys by increasing the amount of food-yolk in the egg, ganoids from the former by again reducing it, and amphibians from these by a still further reduction, and by a new and enormous increase reptiles from amphibians, and so on to the end of the mammalian chapter, we are not really drawing upon an actual tangible, but limited, supply of food-yolk, but simply and solely on the intangible and unlimited resources of the imagination.

If it be suspected that the food-yolk of an egg has either increased or decreased, some cause must have been behind the change. It is only in fairy tales, such as that of "Aladdin and the Wonderful Lamp," that things come into existence from nowhere and out of nothing. As in physical science so also in natural science every effect has a cause and every effect is governed by a law or by laws.

If the food-yolk of an egg can be shown to have increased in amount, we must not forget that the egg has had a history,[1] in past times, and that a plus added to it at or during some epoch of time necessarily entails a minus or abstraction from something else at the same time.

That this must be so may not be obvious at the first glance. But it is all but certain that the cells in the ovary which feed the ovarian egg (follicle cells), or in other cases the ovarian cells consumed by the ovarian egg, are themselves rudimentary or degenerate or sterile eggs. And the amount of nourishment they can furnish in any given instance would seem to be definite and limited. If the egg of an animal increase in size and amount of food-yolk it may in all probability

[1] This might be termed a "phylogenetic history," were it not liable to be misconstrued into confession of faith in recapitulation.

be rightly concluded that fewer eggs have been laid, and that in some form or other more incipient eggs have been used up in the process of forming the functional one.

This conclusion, or suspicion, brings us naturally to the main points of our inquiry, *i.e.* to the modes in which food-yolk has been obtained, and an egg-capsule for the reception of a single egg evolved.

The simplest eggs are admittedly those, like the eggs of many Echinoderms, which contain little or no food-yolk, possess only a single membrane formed by the egg itself, and are laid singly, an egg-capsule being entirely absent.

It is always found that such simple eggs are laid in great numbers, for few or none have been rendered sterile, or degraded to serve as food to the others.

Naturally in such cases the developing organism can attain no great degree of complexity of structure before its original source of food-supply, that contained in the egg itself, is used up. The organism must then hatch out and seek food for itself from extraneous sources. Under these conditions the resulting organism possesses at its birth the simplest possible structure, that of a gastrula composed of two layers of cells and with an aperture leading into the gut.

Apparently there are two ways in which a further supply of food might be bestowed on the developing egg. Some of its fellows might be rendered sterile in the ovary, and there be used up, as in liver-flukes, tapeworms, insects, etc., to increase the food-supply of the remaining functional eggs. Or, a big batch of eggs being deposited together within a simple structureless cocoon, as in earth-worms, leeches, the lug-worm, and the whelk, some might be devoured by others to form a reserve supply of food, as is the case in the whelk.

Whether there is any connection between the two processes is a difficult question to decide. It may be that they have been separately evolved and that they have proceeded along parallel lines in their subsequent history. On the other hand, in some cases, at any rate, it is possible that the latter of the two processes was the original one, and that in course of time it has passed into the former.

If the indications are wanting, that the eggs of lampreys, ganoids, and bony fishes ever passed through the latter condition of being deposited in batches in simple cocoons, the evolution of a skate's egg and purse is only intelligible on this supposition.

Taking the latter process first of all, it will be noticed that it ultimately leads to two results,—to the formation of a large-yolked egg and to the evolution of a complicated egg-capsule for its reception.

In its very beginning the formation of a simple cocoon entails the co-operation of structures external to the ovary in the shape of genital ducts. These are necessary in order that a cocoon, however simple in form and structure, may be produced. It is the entire absence of any such structure in connection with the eggs of lampreys, bony fishes,

etc., which would appear to point to a different history of the yolk in these cases. Reverting to the cocoon, a very simple structure, formed by a genital duct, and containing a great number of small eggs with little food-yolk, may be looked upon as the beginning of the process. The lug-worm, *Arenicola*, furnishes an example. Larvae are developed within the cocoon, and live there as long as they have food to consume. If they then find no other nutriment within this structure they must emerge, and seek for food elsewhere.

Further life within the cocoon is only possible on one or other of two conditions. The substance of the cocoon itself, or a part of it, *i.e.* all except its cortex, may be of a nutritive value. This is so in certain leeches, for instance. Here the larvae, as soon as they reach the gastrula condition, proceed to gorge themselves with the semi-fluid "albumen" of the cocoon, and this food-supply suffices them until the young leech is formed.

But in some animals with simple cocoons the contents of the cocoon apart from the eggs appear to possess no nutritive properties. Undoubtedly it is to be looked upon as a secondary condition, when the gelatinous "white" of the cocoon acquires a food value.

A parallel to this is seen in certain eggs of vertebrate animals. The egg-white of an Elasmobranch egg contains only the merest traces of albumen (Johannes Müller), and is of no use as food. Whereas the same egg-white in a bird's egg is largely albuminous and very nutritive.

But in the simple cocoon, although the substance of this structure is sometimes of no value as a food, there may be unfertilised or undeveloped eggs, or abnormal or degenerated larvae, and these may serve as food for the normal ones. Thus, in the second way, the "birth-period" may be postponed.

There are well-known cases among the Mollusca, *Purpura* and *Buccinum*, in which this "cannibalism" is the normal course of events. A few of the eggs in a cocoon develop quickly, and become gastrulae, with large mouths and muscular gullets. These few very soon use up their own food-supply, and then proceed to devour their fellows, which have either not developed at all, or only gone a little way. If this were carried to an extreme—and it is probable that such cases do occur—it would end in there being only one developing organism left in the cocoon, and this would be gorged with the food-yolk obtained by the annexation of its fellows.

The original cocoon by the solidification of its outer walls, its centre remaining semi-fluid, might thus become an egg-case for a single egg. This would be realised in fact if the eggs to be consumed, instead of being deposited as separate entities within the cocoon, were joined to or devoured by that single one which was destined to develop while in the ovary. The well-known instances of *Hydra* and *Tubularia*, with their ovarian "cannibalism," are obviously illustrative.

When this transference to the ovary of the process of devouring took place, is of course a moot question, but it must have happened at some time or other in many cases. The originally large number of eggs in the cocoon then becomes reduced to a single large one by the conversion of the rest into yolk-material in the ovary itself. And thus, having at first served a rather different purpose, the cocoon becomes an egg-case for a single egg.

Though such an egg contains a large amount of food-yolk in many instances, this cannot be retained during cleavage and the subsequent processes within the cells of the developing organism, and these act as if they were not connected with such an enormous mass of food. The egg now, as in a skate, segments in a disc-like fashion, or is "meroblastic." The object of the developing organism now seems to be to regain possession of the food-mass, which it had been obliged to relinquish during cleavage. This it does by forming once more a gastrula. The latter is flattened out on the top of the mass of yolk, and in order once more to annex this yolk, the gastrula must grow round and enclose it.

So that, if the mass of yolk be large, it appears to be a matter of indifference whether it be added to or devoured by the ovarian egg, or whether it be first obtained by the swallowing of other eggs within the cocoon or egg-case. For the former case ultimately resolves itself in a mere modification of the latter. To put it in another way, the devouring of the yolk-mass has in both cases to be undertaken by the developing organism before it can be said to have obtained real possession of the yolk.

As I have elsewhere written,[1] it is thus that the growth of a blastoderm, *i.e.* of a flattened gastrula over a yolk-sac, is exactly comparable to the devouring of yolk-masses by a whelk-gastrula. The end is the same, and probably the beginning was the same in both.

We have now got but a little distance along the path of evolution of animal eggs, and other interesting problems remain for examination. On another occasion the study of the purse of a dog-fish or skate may engage our attention. From this we may pass to the consideration of the egg of a mammal, and finally, this should lead to the elucidation of some of the principles underlying mammalian development. Food-yolk will here again be found to form an integral part of the programme, and we may perhaps come to realise with what nicety Nature bestows it on animal eggs. And if we glean nothing else, we may at least learn to realise that the reign of law pervades animal development from its commencement to its close.

[1] "The Span of Gestation," Jena, Gustav Fischer, 1897.

UNIVERSITY, EDINBURGH.

The Colours and Pigments of Butterflies.

By M. I. Newbigin, D.Sc.

In a previous issue of *Natural Science*, in the course of a paper on "The Pigments of Animals," an account of the general colour-phenomena of the Lepidoptera was given, and the great interest and importance of the subject indicated. Since the publication of that paper, not a few observers have been engaged in pursuing further investigations, and numerous additional papers have appeared; some of these it is proposed to briefly summarise here. For a somewhat detailed account of the papers published up to the end of last year, reference may be made to the chapters on the subject in my "Colour in Nature" (1898), but preparatory to the consideration of more recent work, the results of these earlier observations may be very briefly stated here.

The researches of Hopkins, Spuler, Urech, Mayer, and many others have shown—(1) that the colours of the wings in butterflies are due sometimes to pigments, sometimes to optical effects, and sometimes to a combination of the two; (2) that pigmental colours are shades of yellow, red, deep brown, or rarely white, green, and pure black; (3) that the white, yellow, and red pigments of the Pieridae, and possibly of other butterflies, are members of the uric acid group; (4) that the red, yellow, and white pigments at least in the Pieridae are chemically nearly related, while the black and brown pigments differ markedly from them, and are of unknown chemical relations. Further, it has been noticed by several different observers that, in the development of colour in the pupa, white or yellow tints first appear, and there is then a gradual darkening of tint as development proceeds—black always being the last tint to appear.

Of the more recent papers with which we are concerned here, we shall take first one by Dr. M. Baer on the minute structure of the wing-scales in diurnal Lepidoptera. In its general outline, the paper for the most part merely confirms the results of others, but on several points it is more detailed, and it is valuable as a clear statement of the general characters of the colours of butterflies and their causes. The value of the paper is greatly increased by the fact that the author did not confine his observations to one family, and therefore is enabled to

clearly point out the differences between the Pieridae and other butterflies.

As regards the optical colours of butterflies, Baer, like Spuler, finds that the particular tint may be due to the sculpturing of the individual scales, or to the combination of different scales. Scales displaying optical colours usually contain pigment in addition, but this pigment does not produce any marked effect on the colour, although it is no doubt a factor in its production. Other apparently optical colours, such as emerald-green, peacock-blue, violet, etc., are, according to the author, produced by the superposition of scales containing pigment, and scales displaying optical colours. The exact physical cause of the optical colours was not ascertained.

Of more importance for our immediate purpose is the treatment of pigmental colours. Histologically, the pigments were found to be of two types—diffused and granular. Pigments of the former type occur diffused through the chitin of the scale, are usually present in very small amount, and include the dark pigments, most yellow, orange, and red pigments except in the Pieridae, and the white pigment (uric acid) of the Pieridae. Contrary to the results of Hopkins, Baer finds that some of the orange and yellow pigments of the Pieridae are diffuse and not granular. Granular pigments occur exclusively in the Pieridae, and are yellow or red in colour. They colour the scales in which they occur very deeply, and associated with this fact Baer finds that such scales are few in number, and almost without surface sculpturing. The superposition of dark-coloured scales upon scales deeply tinted by yellow granular pigment may, as in *Anthocharis cardamines*, produce a greenish tint.

Another recent paper by the Countess Maria von Linden is chiefly concerned with the development of the markings of the wings of butterflies, but incidentally also discusses the order of development of the colours. The author, like preceding observers, finds that those parts of the wing in the pupa which are ultimately black, are first colourless, then yellow or yellowish-white, then orange and orange-red, and finally attain their black tint. The last stage, the development of the dark tint, is not due to a replacement of the lighter pigments, but to a superposition of darkly tinted scales over light ones. Optical colours, such as blue, appear later than the dark tints, and are only exhibited by scales which contain dark pigment. Though the paper is not primarily concerned with pigment, it nevertheless is of importance as tending to emphasise the distinction between the dark pigments and the others, and the late appearance in ontogeny both of these dark pigments and of the optical colours.

The two preceding papers may serve as an introduction to a third, a much more elaborate treatise, by Herr M. C. Piepers, on "Colour-evolution in the Pieridae." Under this title the author discusses a variety of topics connected with the colours of butterflies

and colour phenomena in general; but the paper differs from the preceding in that it is concerned with the broad interpretation of facts observed in the field, rather than with the setting forth of the results of special research. As readers of his previous papers are aware, the author speaks with the authority of one having large experience of butterfly-collecting, especially in the Far East. Like many others, he has as a collector been greatly impressed by the phenomena of sexual dimorphism and polymorphism, and colour variation in general; but, unlike many field naturalists, he is unable to accept the suggestion that these are due to secondary causes. On the contrary, he believes that they prove that the colours of butterflies tend to vary in a definite direction; that there is an evolution of colour. In other words, he holds that if certain genera in a given family include species which exhibit colour varieties, then, in the different genera, the colour varieties will be of similar nature, certain colours being in each case characteristic of the less specialised species or varieties, and other colours characteristic of the more specialised forms.

Beginning with this hypothesis, the author seeks, by a series of examples, to determine the course of colour evolution in the Pieridae, and to consider the bearing of his results upon various problems.

By a detailed study of various genera, notably *Tachyris* and *Hebomoia*, he shows (1) that the amount of red in the wings varies greatly; (2) that red and black vary inversely in amount; (3) that in dimorphic species the male has usually more red and less black than the female; (4) that where the fore wings contain much red, yellow occurs on the hind wings, but where red is present in small amount, yellow is replaced by white. To put this briefly, red and yellow on the one hand stand in antithesis to black and white on the other, and red tends to predominate in the males. Further, the conditions under which red occurs, sometimes as a ground colour, sometimes as spots of varying size, together with its late appearance in ontogeny relatively to black, convince the author that red in itself, or in the form of orange or yellow, is the most primitive colour in the Pieridae; that black and the dark tints are more specialised, and that as they develop the original red diminishes in amount and fades to orange, yellow, and ultimately white. The process which results in this gradual decoloration of the primitive pigment does not, however, end at white, but ultimately results in the loss of the scales themselves; forms like *Macroglossa fuciformis* L., and *M. bombyliformis* Ochs., with their glassy wings, being regarded by the author as terminating the course of evolution along this line. Simultaneously with the decoloration of the primitive red pigment, there may be a development of structural colour, but the relation of this to the dark pigments

is unfortunately not considered. The obvious difficulty that in ontogeny white appears before yellow or red, the author ingeniously removes by pointing out that this early white is probably optical, while the white colour of the adult is due to uric acid acting as a white pigment.

We cannot here follow our author into his discussion of the bearing of his results on the chief controversies in regard to colour phenomena, but their relation to concrete details may be noticed.

In the first place, the view that bright scarlet is the most primitive colour in the Pieridae, with the correlated statement that the males in the family are frequently more primitive in regard to their colours than the females, will be found somewhat difficult of acceptance by most. At the same time, when it is recollected that the examples chosen were largely tropical forms, that the red and yellow pigments are chemically nearly related, and that there is some evidence to show that various external conditions, especially heat, are of importance in the production of red varieties from forms normally yellow, it would seem that our author's statements can be reduced to the simpler form that red, yellow, and white are primitive colours in the Pieridae, and, in nature as in the laboratory, are readily converted into one another. When we remember that these three colours in the Pieridae are due to uric acid and its derivatives, there seems nothing improbable in the suggestion that in the course of evolution they tend to disappear as the dark pigments develop, and are replaced by the brilliant optical colours which are apparently associated both with these dark pigments and with the progressive differentiation of the scales. Such a suggestion I have indeed already made in "Colour in Nature." Piepers seems, however, disposed to apply his theory not only to the Pieridae but to butterflies in general, in which pigments certainly allied to uric acid have not yet been demonstrated. We have just seen also that Baer's work tends rather to emphasise than to destroy the distinctions between the pigments of the Pieridae and of other butterflies. On the other hand, the fact that in the case of species of *Papilio* and *Vanessa* the Countess Maria von Linden found that black was the last colour to develop in ontogeny; that the wings of pupae were first yellowish-red; and that those early colours were later concealed by the development of dark scales on the top of the light ones, certainly suggests a course of evolution similar to that occurring in the Pieridae. The question is not likely to be decided until we know the exact relation of the bright pigments of other butterflies to those of the Pieridae. Nor can we hope to clearly understand the colour phenomena of the Lepidoptera in general, until we also know the relation between the dark and the bright pigments,

the origin of both, and the relation between the development of dark pigments and of optical colours. When these points have been determined, we may hope to be able to take a fresh survey of the whole field of colour, with some prospect of reaching definite conclusions as to the immediate cause of colour variation. The colour variations of the Lepidoptera have always been objects of great interest, and it may be looked upon as a hopeful sign that so many biologists are endeavouring to discover their evolution value, instead of being content to point out how they may be useful to the species.

Finally, whatever may seem doubtful or speculative in Piepers' suggestions, his observations, together with those of the other authors named, point at least to one definite conclusion which is worth emphasis. They seem to confirm the view, supported by many recent investigators, that there is an intimate connection between the colours of organs and their general structural peculiarities. Thus, in the present case the colours of individual scales do not change very markedly in development, but the early scales with their primitive tints are covered up by scales bearing the hues of the imago. Similarly, in the adult, scales exhibiting the more primitive colours are of simple structure, and are replaced in phylogeny by scales of more complex structure and more specialised tint. This is a point of much importance, for it tends to show how far colour changes are from being superficial, how intimately they are connected with the other characteristics of the organism.

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SCHOOL OF MEDICINE FOR WOMEN,
EDINBURGH.

The Red and Blue Colouring Matters of Flowers.

By P. Q. Keegan, LL.D.

In my previous paper (see *Natural Science*, 1898, xii. pp. 194-199) it was maintained that the tannic chromogen of the blue colouring matter of flowers is not the same as that of the red pigment. The old investigators of this attractive subject were not all of one mind in the matter. The great majority unequivocally held that the blue was the original colour, and that the red was merely a derivative thereof, *i.e.* merely an unessential modification, or a product of further deoxidation or dehydration. The French chemist Filhol was for a time evidently in a state of considerable doubt and hesitancy. In his last contribution on the subject, dated 25th June 1860, he states that in examining the colouring matter of red, rose, or blue flowers he had been struck with the differences which it presents according as it is taken from such or such a flower; he noticed that a great number of flowers become blue in contact with alkalis, while others become green, and, moreover, that the pigment of the former enjoys a greater stability than that of the others. "At first," he says, "he thought he could conclude that in deep red flowers there exist two distinct colouring matters, one more stable than the other, but he soon saw that it was not so when he operated on solutions of pure cyanine; there are not two kinds of cyanine." It is all the more remarkable, therefore, that the illustrious Berzelius, who had chemically examined the red pigments of cherry and gooseberry fruits and leaves, should conclude that their colouring matter is not, as had been thought, a combination of a blue pigment with an acid. "What had given occasion for this error," he says," "is that by treating the juice of the berries with acetate of lead blue precipitates are obtained, but this blue colour is due to the impurity of the juice in consequence of the presence of citric and malic acids." It is hardly necessary to observe that for a very long time it was well known to chemists that the blue colours of flowers were reddened by acids, and even that the tint of flowers naturally red was made more vivid and brilliant by the addition of a trace of acid. But this fact, remarkable as it is in its way, seemed comparatively trifling so long as the various and divers pigments of plants were regarded as

merely modifications of only one fundamental substance. Tainted with German alchemical mysticism, Schubler and Frank, A. P. De Candolle, and Marquart successively sought for and insisted on the close connection and genetic relationship of the reds, blues, and yellows: they went further, they proclaimed that the colours of flowers were all derived from and indissolubly bound to chlorophyll.

Now, it is obvious that no thorough and complete scientific understanding of this subject could possibly be attained so long as this sort of poetically "evolutional" imagination held the field. How eminently, then, does it stand to the credit of those acute and able chemists, Frēmy and Cloez, Martens and Filhol, that they were not moved or deterred in the slightest degree by the *à priori* postulates of their German predecessors, that, in fact, they entirely ignored the connection of these brilliant colours with chlorophyll. No doubt Filhol declared that "there is the most direct analogy between xanthine and chlorophyll," but he never sought to derive the one from the other. He and his collaborateurs examined the floral pigments in and by themselves, they were never troubled with evolutionary imaginations and hypotheses, and hence they led the way to discoveries which fitly served as bases and props for further research and enlightenment. Berzelius had little doubt that pure chlorophyll may be the origin of the yellow and red colouring matters of autumn leaves, but he admits that he was never able to reproduce chlorophyll by means of xanthophyll, nor transform chlorophyll into xanthophyll. Mohl, in 1837, would not admit that chlorophyll has any relation with the red colour of autumn leaves, but he does not deny its intervention, though only indirectly, in the red colour of fruits; there is nothing to show, however, that he considered that there was any chemical connection between these bodies. In 1850 Morot, in criticising Marquart's views, observes that "chlorophyll is not found in the most superficial layers of cells where the blue, violet, and red colouring principles are chiefly found; in the more deeply situated cells of the mesophyll there exists much chlorophyll, and at a certain epoch the red substance is seen to take birth there, but at the same time the chlorophyll persists, and this red substance seems to proceed from cell sap, which is colourless beforehand; this sap by the prolonged action of a weak acid becomes red without passing by blue." This passage seem to me to be the very first distinct and definite declaration on chemical grounds, partly at least, that the green matters of leaves are not connected with the red and blue matters, although, as Morot admits, it may be affirmed that chlorophyll, anthocyan, and the red matter may be modifications of one and the same substance; but it is hardly necessary to rejoin that this is totally different from the affirmation that the blue pigment is a direct derivative by dehydration of chlorophyll itself, as Marquart maintained.

In 1858 Morren published his famous "Dissertation sur les feuilles

vertes et colorées," in which he, with great acuteness, insisted that the red and blue colouring matters of plants are not formed from chlorophyll; and the blue colouring matter (anthocyan) is probably, like litmus, the alkali salt of an acid which in the free state constitutes the soluble red pigment (erythrophyll) of autumn leaves. It will be noticed also that Morot had clearly enounced that a red colour could possibly be formed independently in the leaf, in fact it is seen to be produced without having previously passed through a blue tint; in other words, it was not derived from the blue. Here, then, there was a further break up of the olden entanglement, for not only were the blue and red separated from the green, but the red was threatened with divorce from the blue. Now, it was just precisely at this critical point in the scientific enlightenment of the mystery that two papers were published which may rank among the more interesting efforts of an epoch fertile in important researches and discoveries.

In the *Botanische Zeitung*, dated April 18, 1862, there appeared an article entitled "Some Propositions anent the Physiological Meaning of Tannin and of the Pigments of Plants" by A. Wigand, in which the author, after giving various illustrations, and leaving chlorophyll, anthoxanthin, indigo, etc., out of account, avers that "in general it results from the foregoing as to nearly all blue and red pigments that these proceed from tannin through an only unessential modification." . . . 'A colourless substance dissolved in the cell sap furnishes the basis for anthocyan, and this chromogen is tannin, or rather some modification of tannin (cyaneogen): the transformation of cyaneogen into anthocyan depends on an oxidation." Again, early in 1863 Professor W. Stein suggested that the red colouring matter of flowers was paracarthamin, a red substance which he had obtained by the action of sodium amalgam on the plant-yellow (rutin) that had been discovered by Weiss in 1842.

Notwithstanding the extreme suggestiveness of the declarations just now set forth, appealing as they did most forcibly to the scientific intelligence, it is extremely discreditable that, so far as concerns Germany, they were practically ignored for nearly twenty years. No doubt Wiesner, alluding to Wigand's paper, had published some observations about eight months afterwards, and again in 1872; and Kraus, in 1872, had connected the red coloration of winter leaves with the presence of tannin. But it was not till 1881 that Detmer confirmed the views of Kraus, and H. Pick, in 1883, by an elaborate histological and micro-chemical investigation of young shoots, older stems, petioles, fruits and their peduncles, and autumn leaves, fully and amply extended and ratified the propositions enunciated with such brilliant genius by A. Wigand. "We now," he states, "on the basis of our researches, assert with Wigand, as a fact, that the red pigment is to be found only in plants containing tannin, and that the tannin, at first colourless, can change into the red pigment, which likewise reacts like tannin."

Meanwhile, however, the remarkable differences which are observable in red and blue flowers and their colouring principles towards certain reagents, especially dilute ammonia, or ammonia vapours with or without the presence of added acids, still continued to excite comment and acute controversy. So far back as the year 1824 Macaire of Geneva, having noticed that a red infusion of *Viola odorata*, when mixed with a vegetable alkaloid, such as quinine or strychnine, gradually retakes the natural blue tint of this flower, suspected that its colour is owing to a combination of its chromule with an alkali. In 1825 Schubler and Frank testified that the infusion of *Funkia ovata* treated with an acid and then with an alkali may present in the same vessel all the colours of the spectrum. De Candolle was perfectly aware, in 1832, that the infusion of certain red flowers which have been acidified assume a blue colour when treated with alkalis, and, on the other hand, that the acidified infusions of blue flowers do not reassume their original colour when similarly treated. Frèmy and Cloez asserted that anthocyan was reddened by acids and greened by alkalis. Wigand stated that the colouring matter dissolved in acid cell saps became by alkalis first blue and then green. Wiesner, on the other hand, stoutly maintained that anthocyan as such or in itself was always blued by alkalis and never greened: it is only when it is present along with a substance which is coloured yellow by alkalis that it passes by the latter body into green, which thus arises as a mixed coloration. In 1867 Naegeli and Schwendener again asserted that anthocyan is blued by alkalis and then passes into green; and Sacchse, in 1887, expressed concurrence with this view. All this diversity of opinion concerning a matter which, one might imagine, is capable of being settled once and for all by the application of definite tests, would undoubtedly never have come to pass if there had not been "something in it," as they say. The remainder of this paper will be devoted to an attempt to explain precisely what this mysterious "something" is.

In the first place, it will be advisable to enumerate at least some of those flowers whose colouring matters are known to be blued by ammonia vapour and by a dilute solution of ammonia. The following list comprises some of the most notable examples:—*Fuchsia*, *Pelargonium* sp., *Plumbago*, blue sp., *Lycium barbarum*, *Phaseolus multiflorus*, *Erythrina crista-galli*, *Echinacea scrotina*, *Impatiens balsamina*, *Salvia splendens*, *Polygonum orientale*, *Camellia*, Paeony, and deep-red garden Rose (acidified alcoholic extracts). There are doubtless many more, but the study of these may suffice to throw some light on the subject. Assuming what has been abundantly proved, viz., that tannin constitutes the chromogen of the red and blue floral pigments, and that tannin is not a homogeneous chemical compound, but embraces many varieties, we must ascertain if there exists any kind of tannin in the aforesaid flowers different from that which occurs in the

ordinary red or blue flowers which are coloured green by dilute alkalis. Now, it would appear that the majority of flowers contain either rutin or an iron-greening tannin, but a select few, including *Fuchsia, Pelargonium, Paeonia,* and *Camellia,* undoubtedly contain an iron-blueing tannin which is no other than gallo-tannin mixed probably in some older specimens with a small quantity of gallic or ellagic acid. The ordinary pink rose contains only a highly phloroglucin-bearing tannin common to the whole order to which the queen of flowers belongs; but in certain garden varieties, wherein the petals have immensely developed with full expansion of parts and profound depth of coloration, a small proportion of gallic acid has doubtless managed to find entrance into the cells of the corolla. In fact, Filhol, Rochleder, and others found gallic acid as a constituent in the well-preserved and intensely purplish crimson cones of the officinal *flores Rosae rubrae;* and similar remarks will apply to the case of *Polygonum orientale.*

The residue of the flowers in the foregoing list belong, it will be observed, to the orders Solanaceae, Plumbaginaceae, Labiatae, Compositae, and Leguminosae, all of which are distinguished by the absence of free phloroglucin, a fact which affords an insurmountable presumption that the tannic chromogen is of a character distinct from that with which we have just dealt. All who have had some experience in the chemistry of herbaceous plants are fully aware that they are brimful of quercetin in the form of rutin, etc., which, however, of itself fails as a basis for brilliant colorific effects, but may, nevertheless, by further de-assimilation develop into tannins which, in the special instances now under review, belong to the distinctively iron-greening class. The question which is now started and remains to be discussed is, whether this iron-greening tannin is adequate to discharge the function of a chromogen competent to evolve a pure blue flower?

All the genera mentioned are, with the exception of *Erythrina,* capable of producing a blue or purple flower in some of their specific forms. *Fuchsia, Plumbago, Lycium,* and *Salvia* produce one or more pure blue efflorescences; while *Pelargonium, Phaseolus, Echinacea, Impatiens, Polygonum, Camellia, Paeonia,* and *Rosa* produce purples more or less deep and frequently approaching deep blue. Of all these, *Fuchsia, Plumbago, Pelargonium, Lycium, Polygonum, Camellia, Paeonia,* and *Rosa* contain either an iron-blueing tannin or gallic acid in small quantity, and it is the colouring matter of just these flowers which is most distinctively blued by ammonia vapour or solution. In point of fact, I think it must needs be concluded that in all these instances it is the gallic acid resulting from the oxidation of gallo-tannin or of some nearly allied benzene derivative, which is solely responsible for the blue more or less pure and clear which they so beautifully display. *Rosa* and *Polygonum* are exceptional, inasmuch as they are genera which contain a highly phlobaphenic tannin, *i.e.* a chromogen which

on advanced oxidation evolves brown-red or muddy anhydrides more than sufficient to neutralise and overcome any tendency to blue coloration incident to the presence of gallic acid.

Nevertheless, it is evident that gallic acid is not the only substance that may officiate as chromogen in the outcoming of vivid and brilliant blues. The genus *Linum* presents a remarkable phenomenon in this connection. Of some fifty species of this genus about seventeen are pure blue, and the rest are either yellow or purple, lilac, crimson, rose, pink, or pure white. The most astonishing species is *L. grandiflorum* (*coccineum*) which is the one crimson amidst a genus predominantly blue: it contains no gallotannin or gallic acid, but there is some rutin and iron-greening tannin, and there is a small amount of free phloroglucin in the plant itself. Now, if ever there was a red flower which is or has been naturally and originally blue it is this one, as the following reactions will show. The alcoholic extract of the petals is of a magenta-red colour, and the filtered aqueous extract of its evaporated residue yields with acetate of lead a blue colour, and then when acetic acid is added in large excess the *blue* colour still remains; with subacetate of lead it gives a pure blue colour; with bicarbonate of soda a grayish-blue turning grayish-green, and with oxalic acid added a bright scarlet red is obtained; with acetate of magnesium a splendid green, and when acid is added the original red is restored. Thus we see that in the presence of heavy bases the blue coloration persistently remains even in the presence of a considerable excess of free organic acid; with light and feeble bases, on the other hand, the addition of a small quantity of acid determines a distinctly red reaction. And all these facts seems to me to demonstrate what I consider to be quite exceptional, viz., that in *Linum coccineum* the red coloration of the flowers is produced by the accidental presence of free acid affecting a naturally blue pigment. It is hardly necessary to subjoin, that in the vast majority of cases, whether the flower be either red or blue, the particular tint is not influenced or created by the neutral or acid condition of the cell sap.

By what circumstances, then, is the particular tint created or influenced? In order to answer the question satisfactorily two facts must be minutely considered:—1. Chemical, the presence of quercetin in the form of rutin, etc., in the corolla. 2. Physiological, the possession by the corolla of energetic respiratory and transpiratory functions, with the result that the substances contained in its cells undergo an oxidation more or less vigorous and complete. In my previous paper I showed that the red pigments of flowers were specifically incidental to tannic chromogens which contain phloroglucin in their molecules and yield phlobaphenes, *i.e.* a series of anhydrides, the lower of which are crimson and the higher are red-brown; while the blue pigments were incidental to acid tannins or to tannins which yield acids on oxidation. Now, only a slight chemical experience is requisite for the under-

standing that in the latter case the process of oxidation has been more energetic and more complete than in the former case. Even where the blue is apparently the result of a combination of a tannic acid with a base, the effect cannot be produced save under circumstances especially favourable for oxidation. The flowers comprised within the great division Corolliflorae having a gamopetalous corolla, enjoy, by reason of the great expansion of cellular surface, a respiratory and transpiratory activity which the Polypetalae cannot exhibit. We see that all or most of our decidedly blue flowers are gamopetalous, *e.g.* gentians, bell flowers, Jacob's ladder, convolvulus, speedwells, various labiates, borage, etc. *Linum perenne* is an example of a bright cobalt blue-coloured polypetalous flower; but it may be readily observed that the petals are very broad and generally large in comparison with the thin and wiry stem and the small strap-shaped leaves; and I know of no valid reason why, under such propitious circumstances, the quercetin of the cell sap may not in the absence as here of any phlobaphenic tannin, develop to the full, and sowise evolve a high oxybenzoic acid which, being immediately transformed into pigment, may not be readily detectable in the free state.

In view of the researches already published, and of my own experiments, I think it may be concluded, that—1. A blue flower is unproducible in species which contain or are capable of forming phlobaphenic tannin, no matter what the development of the inflorescence may amount to. 2. A blue flower is more likely to be produced in a species having a gamopetalous corolla or perianth, and therefore liable to evolve by higher oxidation a certain quantity of a high oxybenzoic acid. 3. In species wherein the tannin natural to the organism is iron-greening and non-phlobaphenic, a blue flower may possibly be producible in a polypetalous corolla, provided always that the petals or perianth be large relatively to the height of the plant and to the size and robustness of its stem and leaves: in this case it is uncertain whether gallic acid is necessary for the production of the effect, but anyway an alkaline compound of an oxybenzoic acid would seem to be indispensable. I hope in a concluding paper to specifically examine these three propositions, and to supply full illustration of their scope and tenor.

11 Queen's Square,
London, W.C.

FRESH FACTS.

NINETEEN DAYS WITHOUT A HEAD. CHARLES JANET.—"Réaction alcaline des chambres et galeries des nids de Fourmis. Durée de la vie des Fourmis décapitées" (*Comptes Rendus Ac. Sci. Paris*, 1898, cxxvii. pp. 130-133). Janet had decapitated some workers of *Formica rufa* in his search for the little Nematode worms (*Rhabditis*), which are parasitic in the head, and was struck by the vitality of the headless bodies. In a moist chamber they all remained alive for several days, and moved their limbs when gently stimulated. Three lived for two days, one for three, two for five, one for seven, two for nine, and one for nineteen. The last was a large worker, with an abdomen distended with food.

USES OF THE SWIM-BLADDER. CHR. JACOBS.—"Ueber die Schwimmblase der Fische" (*Tübingen Zool. Arb.*, 1898, iii. pp. 385-411). The swim-bladder of the eel contains 44·74 per cent of oxygen, 51·97 per cent of nitrogen, 3·29 per cent of carbon dioxide, and this mixture is reduced in amount when the eel is kept out of water. The gas is *probably* liberated by the vascular wall of the air-bladder, and the oxygen is *probably* absorbed again by the vascular wall of the pneumatic duct. In pike and perch there seems to be no respiratory function, but the organ *probably* serves to regulate the specific gravity of the fish. In *Cobitis fossilis*, which can live in non-aerated water by gulping air at the surface, the small, apparently rudimentary, swim-bladder is enclosed in a bony capsule, and can hardly be supposed to help in breathing. This function seems to be discharged by the thick capillary network beneath the epithelium of the intestine.

WITCH'S MILK. S. G. TSCHASSOWNIKOW.—"Chemische Untersuchung der Hexenmilch" (*Le Physiologiste Russe*, 1898, i. pp. 68-72). The milk which is formed by the mammary glands of both sexes soon after birth, attaining its maximum in the third week, and disappearing completely during the next fortnight, has often been examined microscopically, and is well known to contain the same corpuscles as ordinary milk, but it has been analysed only three or four times. The last analysis shows that the component substances are the same as in the milk of normal lactation, but the proportions are different. It contains more water and salts, but much less proteid, sugar, and fat. Its proportions closely resemble those of asses' milk.

MAKING OF MUSCLE. ALEX. MEEK.—"Preliminary note on the post-embryonal history of striped muscle fibre in Mammals" (*Anat. Anzeig.*, 1898, xiv. pp. 619-621). In the field-mouse, the cat, and the tame rat, hypertrophy of the fibres occur, accompanied by a reduction in their number,—a good instance of "the struggle of parts within the organism," as Roux phrased it.

WHAT IS A BRAIN? J. STEINER.—"Die Funktionen des Centralnervensystems und ihre Phylogenese," iii. Abth. Die wirbellosen Tiere (Braunschweig, 1898; see *Biol. Centralbl.*, 1898, xviii. pp. 749-751). The author

has defined a brain as the general motor centre associated with at least one of the higher sensory nerves. In this sense there is a brain in the supra-oesophageal ganglia of Crustacea and Tracheata, but not in Molluscs, Annelids, Nemertines, or Planarians, not to speak of Echinoderma and Coelentera. In the dorsal ganglion of *Octopus* there seems to be a cerebrum in the Vertebrate sense, but not a real "brain."

EVOLUTION OF THE BRAIN. B. HALLER.—"Vom Bau des Wirbelthiergehirns," I. Theil, Salmo und Scyllium (*Morphol. Jahrb.*, 1898, xxvi. pp. 345-641, 11 pls. and 23 figs.) As a speculative conclusion based on a multitude of facts, Haller suggests that the ancestor of the Chordata (the Helminth, to wit) had for its central nervous system a pair of supra-oesophageal ganglia and lateral nerve cords. The latter approached dorsally and coalesced in a single cord, whose central canal remains as a sign of the primitive separateness. The canal was continued forward to the primitive brain, probably the region of the ganglia habenulae, where a similar cavity arose by a fusion of the ventral parts of the ganglia. Thereafter followed a metameric differentiation of the nerves, both cranial and spinal, while the formation of the Vertebrate eyes and the concentration of the olfactory spheres gave an early impulse to anterior cerebral differentiation.

CHANGES IN THE DENDRITES. S. SOUKHANOFF.—"Contribution à l'étude des modifications que subissent les prolongements dendritiques des cellules nerveuses sous l'influence des narcotiques" (*La Cellule*, 1898, xiv. pp. 387-395 1 fig.) "L'anatomie pathologique de la cellule nerveuse en rapport avec l'atrophie variqueuse des dendrites de l'écorce cérébrale" (*T. C.*, pp. 399-415, 4 figs.) In the guinea-pig intoxicated with trional, poisoned with arsenic, subjected to thyroidectomy, or otherwise treated so as to bring about marked nutritive disturbances, the dendritic prolongations in the cells of the cerebral cortex become markedly moniliform or varicose, which probably implies a degenerative process associated with relative atrophy. The particular interest of this is, that traces of the moniliform state are to be seen in the normal condition.

THE LENS OF THE MOLE'S EYE. C. RITTER.—"Die Linse des Maulwurfes" (*Arch. f. mikr. Anat.*, 1898, liii. pp. 397-403, 3 figs.). The minute lens is without a nucleus and without concentric structure, in fact, rather like a half-made lens in the frog. It permits the passage of light, but is quite incapable of forming an inverted image. If any image is formed on the retina it can be little better than a tangle of lines.

A SHOWER OF FOSSILS. LORTET.—"Chute de Crustacés ostracodes fossiles observée à Oullins, près de Lyon, le 24 Septembre 1898" (*Comptes Rendus Ac. Sci. Paris*, 1898, cxxvii. pp. 1231, 1232). On a calm evening, about sunset, Lortet observed, near Lyon, a thick and rapid shower of fossil Ostracods (*Cypridinia*), and heard the minute shells rustle the withered leaves. They had no doubt been caught in an ascending air-current from some of the regions in North Africa, where they abound.

SOME NEW BOOKS.

HERTWIG'S THEORY OF BIOGENESIS.

Die Zelle und die Gewebe. Grundzüge der allgemeinen Anatomie und Physiologie der Gewebe. Zweites Buch. By Prof. Dr. OSCAR HERTWIG. 8vo, pp. viii. + 314, with 89 illustrations. Jena: Gustav Fischer, 1898. Price 7 marks.

Although this book comes at an opportune moment, when the controversial fires of the "evolutionists" and "epigenetics" are burning low, and contains many interesting observations, it will not, in our opinion, mark any great epoch in the history of the subject. Even the most determined opponent of the neo-evolutionistic school will probably admit that Weismann's latest most important work, "The Germ-plasm," is, in some respects at least, a work of genius; but this could be hardly said of the present volume. Indeed, after reading the three hundred odd pages it contains, we must confess to a feeling of disappointment that Dr. Hertwig has not been able to state a stronger case for himself and his colleagues. As a destructive critic he is generally convincing when he attacks the "evolutionists," and he has no doubt done valuable service in overthrowing much of what was at one time freely accepted by many biologists as fact, which can now be no longer upheld in the light of recent observation and experiment. But we much doubt whether his "Theory of Biogenesis," which explains development partly from an "evolutionistic" and partly from an "epigenetic" standpoint, will be very widely received. We believe that many of Dr. Hertwig's deductions are founded on unsound premises. For instance, we hesitate to place very much value on the results of those experimental embryologists, *e.g.*, Loeb and Herbst, who submit developing organisms to conditions seemingly impossible in a natural state. Their results are interesting, and deserve to be carefully noted, but they can very easily be made to prove too much, and then become exceedingly dangerous pitfalls from which, in our opinion, Dr. Hertwig has not escaped. He is, however, much to be congratulated in fighting shy of metaphysics and reserving himself to the facts of embryology, cytology, and medicine and surgery, taken from sources probably unknown to the general biologist; while there can be no doubt that a careful study of the work will open out many new paths of research. Herein, we think, lies the great merit of the book.

The first four chapters are devoted to a comprehensive study of the cell in relation to its neighbours, and deals especially with the organic connections between the cells composing the bodies of animals and plants. The author then goes on to point out how many external forces there are continually at work in the environment of an organism which produce the most complicated effects on it, but these depend also on the nature of the organism itself. The fact that fertilised ova of two very different forms develop in what are apparently identical circumstances, shows that much depends on the internal molecular structure of the ovum. This leads on to a comparison of the rival theories of the "evolutionists" (Weismann,

Roux, Poulton, etc.), and of the "epigenetics," (Hertwig, Driesch, Morgan, etc.), in which he satisfactorily disproves Weismann's fundamental assumption of the "qualitative" (*erbungleich*) division of the idioplasm of the nucleus, but yet admits that such an idioplasm must exist, and so paves the way towards an explanation of his "Theory of Biogenesis." Development, according to Hertwig, depends on two sets of factors: (*a*) external; (*b*) internal. Under the first he groups the various effects of environment, and discusses at length the influence of such forces as gravitation, stress, and pressure in the formation of organic tissues. Much space also is devoted to the influence of light, temperature, and various chemical substances on developing animals and plants. Among the internal factors Dr. Hertwig deals chiefly with the correlation existing between the cells themselves and between the organs they compose. These chapters form perhaps the most important part of the book, for although it is generally admitted that correlation must play an enormous part in ontogeny and phylogeny, yet in text-books it is rare to find more than a few trite instances quoted, such as the deafness of blue-eyed white cats, etc.

We have also a mass of information with regard to the latest results of experimental embryologists as to the phenomena of regeneration. After discussing the many pathological changes undergone by cells, Dr. Hertwig finally deals with such controversial points as the inheritance of acquired characteristics, and the part played by the idioplasm of the cell itself, and concludes with a sketch of the way in which his theory has gradually been evolved. It may be briefly summarised as follows:—

(1) Every cell has its own specific characteristics.

(2) The hereditary material which one cell passes on to another is lodged in the nucleus.

(3) The invisible specific distinctions of an ovum give rise to the visible specific distinctions of an adult organism solely by multiplication of cells, and their actions and reactions upon one another.

(4) The differences of cells are not produced by their receiving different portions of the hereditary substance. All receive like shares, but do not respond alike to external and internal stimuli. The fate of a cell largely depends on the exact position it holds with regard to its neighbours.

(5) Except in the lowest forms of life, each cell, as development proceeds, gradually loses the power of reproducing the whole organism, but the germ cells are exceptions to this rule.

(6) Besides possessing hereditary substance, a cell, if it is to develop into an organism, must possess the power of responding to certain external conditions. Unless these latter are present development is impossible.

In reviewing this book, all that has been possible to do is to give a bare outline of Dr. Hertwig's methods and general aim, and we must leave the reader to draw his own conclusions. Many, no doubt, will be satisfied with the results arrived at. All will congratulate Dr. Hertwig on the completion of his work, albeit some may be more than ever convinced that the end of this century sees us still in almost complete ignorance of the causes of organic development.

M. D. HILL.

LOST LINKS SUPPLIED.

The Last Link. Our Present Knowledge of the Descent of Man. By ERNST HAECKEL. With Notes and Biographical Sketches by HANS GADOW. 8vo, pp. 156. London: Adam and Charles Black, 1898. Price 3s. 6d.

About half of this little book, which seems dear for its size, is occupied with the address which Professor Haeckel gave at the Congress of Zoologists at

Cambridge, the other half contains Dr. Gadow's notes, and it is difficult to say which half is the more interesting. With his wonted clearness and decisiveness Haeckel sums up the conclusions set forth at length in his "Systematische Phylogenie," and traces the presumed evolutionary stages from Monera to man. Due use is made of *Palaeospondylus* and *Pithecanthropus* and other recent discoveries, while some hypothetical groups are utilised to eke out the imperfect geological record. The essay must be taken as a sketch of phylogenetic possibilities—and the possible has a wide radius in phylogeny—for it need hardly be said that there is room for much difference of opinion as to the systematic position of many of the types. What we are afraid of is that the uncritical and unsuspicious may infer from this lucid exposition that there is no longer any doubt that "the Dipnoi form the actual link between fishes and Amphibia," that "*Sphenodon* is the reptile which stands nearest to the main stem of our ancestry," or that the acknowledgment of the affinity of Vertebrates and Tunicates "has abolished the erroneous hypothesis that the Vertebrata may have arisen from Annelids or from other Articulata." These and many similarly decisive statements may turn out to be true, but surely there is at present warrant for a reasonable argument over any of them. We have great admiration for Haeckel's genius, but his decisiveness often becomes perilously like dogmatism; nor can we conceal our disappointment to find him saying that it would be better to return to the Mosaic cosmogony than to agree with Weismann.

Dr. Gadow furnishes terse and vivid biographical sketches of Lamarck, Etienne Geoffroy Saint-Hilaire (variously referred to also as Geoffroy, Geoffroy Saint-Hilaire, and Saint-Hilaire), Cuvier, von Baer, Johannes Mueller, Virchow, Cope, von Koelliker, Gegenbaur, and Haeckel himself. Besides these sketches, there are notes on the theory of cells, factors of evolution, and geological time. Here and there we notice what appear to us to be defects in the historical notes, and we venture to give three illustrations. In discussing Lamarck's position is it not well to point out that, as regards the evolution of plants, Lamarck laid the main emphasis on the direct action of the environment? In speaking of Etienne Geoffroy Saint-Hilaire, Dr. Gadow says "he maintained that, since Nature takes no sudden leaps," etc., but is it not to this author that we owe some of the first suggestions as to saltatory or transilient variations? Dr. Gadow credits Huxley with the terms "ectoderm" and "endoderm," but were they not Allman's invention? We might ask other such questions, but it seems ungracious, for the notes are delightful. Not least so is the one with which we disagree most heartily—that which maintains that adaptation and variation are simultaneous and fundamentally the same, and that acquired characters are inherited. X.

GEOMORPHOLOGY.

Earth Sculpture. By PROFESSOR GEIKIE, LL.D., D.C.L., F.R.S. 8vo, pp. xvi. + 320, with 2 plates and 89 figures. Progressive Science Series. London: John Murray, 1898. Price 6s.

During the Victorian era the origin of the earth's surface-features has been studied by many geologists, especially by those whose vocations have kept them much out of doors. Ramsay, Jukes, Whitaker, Foster and Topley, Lapworth, both the Geikies, and others in Britain, and a host of workers in America and on the Continent, have all contributed to our present knowledge of the genesis of land forms. During the last ten or fifteen years many of those whose business it had hitherto been to record geographical facts without concerning themselves as to how the phenomena had been brought about, have awakened to the importance of learning *why* these features have taken on their present form. In

other words, geographers are now realising that if we are to obtain any scientific knowledge of geographical forms, we must first discover how these forms have arisen. Geologists have for many years concerned themselves very much regarding this particular question, and now their fellow-workers the geographers are realising the importance of making up for lost time, and are specialising more and more every year in their studies of the origin of land features. So rapid are the strides that have been made in this direction within the last decade that the geologist is already beginning to be left behind. Those who have closely followed the development of the science of Geomorphology are fully aware that its foremost exponents at the present day are to be found in America; and on the Continent there are arising many workers who bid fair ere long to distance even their American brethren.

Thus it happens that the development of Geomorphology has reached a phase at which that science forms a kind of debateable land between the respective territories of the geographer and the geologist; and, indeed, it seems destined in the near future to take up a position as an independent science, which will bear much the same relation to its parent sciences that Mineralogy does to Chemistry and Mathematics, or that Palaeontology does to Biology and Geology.

For many years Professor Geikie has been one of our foremost exponents of this branch of his science, and in the handsome volume of nearly three hundred pages which Mr. Murray has published under the title of "Earth Sculpture," the author has given us a summary of his own views on the origin of surface-features in general, and in particular of those of his native land. The book is written with that lucidity of style for which the author and his brother have so long been famous. The get up of the book, as one might have expected from the reputation of the publishing firm, is in every way excellent. Besides the 89 figures in the text, there are two reproductions of photographs by Mr. W. E. Carnegie Dickson, showing in an admirable manner the mural weathering of granite in Glen Eunach, in the Cairngorm Mountains. J. G. G.

HENRY DRUMMOND.

The Life of Henry Drummond. By GEORGE ADAM SMITH. 8vo, pp. 506, with portrait. London: Hodder and Stoughton, 1898. Price 7s. 6d.

The author, who was intimate with Drummond from their college days until the end, has gathered all possible material for his work, and no one else could have written the book half so well. Its only fault was inevitable; one learns of the extent of Drummond's life, but its peculiar harmony is somewhat lost; memory is still too particular and sharp; the book is new wine.

Perhaps the author might have estimated more highly the significance of Drummond's larger writings. They are the only spontaneous and ingenuous flower of the doctrine of design within many years. Drummond lived in the impression of nature and experience as one and divine; it was accidental that as Böhme, under the same impulse, used astrological terms, so Drummond spoke in the no less inadequate language of current scientific doctrine. He found the unity of the world neither in its dust, nor in a blind monstrous will, nor in a dead system of concepts, nor in anything poorer than man, but in that which is at least human all through. He seriously attempted a Theistic and even a Christian doctrine of nature and experience, and he studied living creatures and men's lives in detail to that end. His work was premature; it was an impression rather than a construction; but it stands as an isolated example of that attempt without which theology cannot live. But the student was only part of the man, and probably not the chief part; these pages show an experience and a nature of unusual width and graciousness. S.

VERTEBRATE PALAEONTOLOGY.

Outlines of Vertebrate Palaeontology for Students of Zoology. By ARTHUR SMITH WOODWARD. 8vo, pp. xxvi + 470. Cambridge: University Press, 1898. Price 14s.

This is a work to which all students of vertebrate palaeontology have been looking forward with lively interest, both because of the reputation of its author, and of the peculiar advantages which the great collections of the British Museum offer for fresh and original treatment of the subject. The volume is to be read and reviewed for what it purports to be, as explained by the author in the preface and elsewhere, namely, a brief sketch of the palaeontology of the Vertebrata, intended for students of vertebrate morphology and zoology, who are desirous of examining in detail the palaeontological aspect of their subject. It need not be placed beside works of a monographic character, nor even more exhaustive educational works, such as Zittel's "Palaeontologie." And it is greatly needed for the very purpose which the editors had in mind, namely, for students of the various branches of vertebrate zoology, for it is becoming more clear daily that the educational gap between living and dead vertebrates is entirely unnatural; that there are no vertebrates which can be thoroughly understood without recourse to palaeontology. A notable instance of the danger of ignoring palaeontological evidence is found in the numerous errors which persist in the otherwise magnificent "Vergleichende Anatomie" of Gegenbaur, recently published as the consummation of a lifelong work.

In most respects the "Vertebrate Palaeontology" meets its purpose admirably, and can be placed in the hands of students with the teacher acting as a guide. In other respects it is somewhat open to criticism when compared with the best models of didactic writing. Moreover, the prevailing knowledge of Palaeontology is so limited, that the majority of teachers will not be able to give the critical suggestions and corrections which are here and there necessary, in order that the treatment may be transparently clear. This is due, perhaps, to the fact that the author, as an eminent specialist who has not given particular attention to teaching, overestimates the capacity of his student readers. It is true that the style is lucid and admirable, the drawings are well selected and beautifully executed—a very large number of them being original—but in many cases there is an absence of the concise definition and sharp demarcation of the characters of different groups which one finds in such a model work as Huxley's "Comparative Anatomy of the Vertebrates."

While the subject is logically developed, each section being introduced by a concise description of some typical form, there is a looseness and uncertainty in the use of scientific terms and nomenclature which would leave the average student in a state of confusion. For example, the cartilaginous supports spoken of as "endoskeletal rods" (page 19), are defined as "baseosts" (p. 20), where they lie within the fin proper, and the same elements are termed "radial cartilages" later on (p. 30). Similarly, the rods lying within the body are defined as "axonosts" (p. 20), as "basal cartilages" (p. 23)—a term readily confused with baseosts—as "endoskeletal supports" (p. 24).

The query "What's in a name?" so far as it applies to text-books, should be answered by the rule: *A single name is of value; it should be once clearly defined with its synonyms and then used consistently throughout.* A similar indecision is observed in the descriptions of the vertebral elements, especially in the description of the unpaired or ventral vertebral elements, which are termed "hypocentra" in describing the Fishes, "hypocentra or intercentra" in describing the Amphibia, "intercentra (hypocentra)" in describing the Reptilia, and "intercentra" pure and simple in the later portions of the work. Parenthetically it may be observed that, upon page 127, the paired ventral pieces of the vertebrae of the Branchiosaurian and Microsaurian vertebrae are termed "hypo-

centra"; this is possibly in deference to the views of Cope and Baur as to the homologies of these elements, but in the reviewer's opinion both these writers were mistaken, for if these parts are homologised at all with the elements of a compound vertebra, they must be considered as *pleurocentra*, both because of their paired structure, and of their relations to the neurapophyses and ribs.

A similar inconsistency, which is perhaps even more serious, between the earlier and later pages of the work, is seen in the use of the terms "squamosal" and "supratemporal"; all through the portions relating to the Teleostome fishes and Stegocephalia, the dorsal anterior element immediately behind the post-orbital is termed "squamosal," while the ventral or posterior element is termed "supratemporal." In the latter part of the work these terms are reversed, and the ventral posterior element in contact with the quadrate is properly termed "squamosal"; while the dorsal anterior element in the Theriodontia, Pythonomorpha, and most subsequent sections is properly termed "supratemporal" or "prosquamosal" (Fig. 96, p. 153; Fig. 117, p. 192). As pointed out by Baur, these bones were first named by Owen in this manner, and it is obvious that the part nearest the quadrate should throughout be termed "squamosal," because the term originated in mammalian anatomy, in which there is no prosquamosal or supratemporal element.

Another debateable use of terms, which concerns homology, is that upon page 125, in the description of the dermal bones of the pectoral girdle of the Stegocephalia, where mention is made only of an interclavicle and clavicles; the former being regarded by the highest authority, Gegenbaur, not as an interclavicle at all, but as an episternum (that is, a part which originates by the union of dermal elements in the middle line of the chest, just as the parasternum or abdominal ribs originate in the region of the abdomen). There is thus in the Stegocephalia an episternum, a clavicle and a supraclavicle (Seeley = cleithrum, Gegenbaur), and this latter element, which the author fails to mention, is of especial interest because it represents a vestige of the ancestral suspension of the pectoral girdle from the skull, as observed in the Teleostomi. A minor oversight is in the absence of definition of the term "amphistylic" (p. 33), while of more importance is the absence of definition, either in the text or in footnotes, of the important ordinal and subordinal terms, such as "haplistia," "actinistia," "rhipidistia," terms originally applied in full recognition of their phylogenetic significance, and therefore worth fixing in the minds of students by a brief reference to their meaning.

The figures for the most part are extremely good, especially the original synoptic series drawn from Amphibian and Reptilian skulls in the British Museum. They are marred only by the abbreviations, which coincide with the inconsistencies in the use of terms, above pointed out. The Mammalian figures are the least satisfactory because the author has been obliged to borrow more largely. On page 295 is inserted Marsh's restoration of *Coryphodon*, which is to be regretted, because it gives an entirely wrong impression of the chief characters of this animal. Here also we regret the use of the term *Dinoceras*, which is pre-occupied by *Uintatherium*.

It is interesting to turn from these matters, which are of a more or less technical character, to the discussion of the far more important treatment of the relationships, phylogeny, and classification of the Vertebrata. Naturally in this part of the work specialists find their greatest interest.

The author, in the attitude of teacher, rightly takes a conservative position upon most of the open phylogenetic problems. He clearly shows that he leans towards the theory, that the closest relations of the Amphibia are with the Crossopterygian fishes, and of the Mammalia with the Anomodont Reptiles. In tracing the descent of the Mammalia proper, he adheres practically to the theory of Huxley, namely, of the phyletic succession of Monotremes, Marsupials, and of Placentals, the main objection to which is that no evidence can be advanced in its favour. He accordingly regards the Mesozoic mammals, and

especially the Purbeck and Como types as representing only Monotremes and Marsupials; and from this we infer that he considers the Eutheria or Placentals of comparatively late origin. A few errors have found their way into the treatment of the mammals, which may be corrected in a later edition. The teeth of Ancylopoda (page 307) are said to resemble those of the Rhinoceros. This is evidently incorrect, as they stand nearest the teeth of the Titanotheres, and hence of the Artiodactyls. Erroneously, we believe, the author follows Lydekker and Flower in placing all the early Perissodactyla among the Lophiodontidae, disregarding the fact that in the Lower Eocene all the modern families of Perissodactyls are sharply defined. This leads to a further confusion in reference to the family Palaeotheriidae, which is said to approach the Rhinoceroses. The conception of the family distinctness of early ungulates agrees with that held by the author himself in his treatment of the Fishes, namely, that family lines should correspond with phyla, and not with the parallel assumption by distinct phyla of similar characters.

One of the most remarkable things about this work is, that the author appears to be less clear and logical in the major classification of the Fishes, his own special field of work, than he is among the Reptiles. This appears to arise from far too great reliance upon the lines drawn by Reichert and Huxley between "autostylic" and "hyostylic" types, and from setting aside the really fundamental characters of division between cartilaginous fishes in which true bone is absent, and Teleostomes and Dipnoans, which have more or less true bone. Single characters, such as the suspensorium, may be safely employed in major classification, provided first that they are not acquired by parallelism, and second that they really afford sharp and natural lines of division. Hyostylism and autostylism answer neither of these criteria. The Elasmobranchs are grouped by the author as hyostylic (p. 27), although members of this sub-class show every stage of transition between autostylism (*Heptanchus*) and hyostylism (*Raja*). These transitions are obviously adaptations to feeding habits, analogous to those which we observe among reptiles with a loose or swinging, and tight or firm, articulation for the angle of the lower jaw. The autostylic *Chimaera*, with its firmly united upper jaw and reduced hyomandibular, is adapted to a mode of feeding upon small molluscs and crustaceans not very dissimilar from that of the lizard *Sphenodon*, in which the food is firmly seized by the anterior teeth and cut up by the molar plates. The loose and swinging shark jaws, with the hyomandibular acting as a supporting bar, are to be compared with those of snakes, in which the mouth is very expansible, and the food is swallowed whole, the backward-pointing teeth serving to prevent escape. Moreover, these terms are misapplied by the author not only in sharks, but in other specific cases. The Crossopterygians (p. 69) are defined as "hyostylic" (a character by the way which would seriously interfere with their position among the ancestors of the pronouncedly autostylic Amphibia), and this is an error, for, as observed by Pollard, "On examining the hyomandibular it will be seen that it can take very little part in the suspension of the jaws."

We thus conclude that a close examination of the suspensorium of all the living and extinct fishes proves that "auto-," "hyo-," and "amphistylism" are at the most ordinal characters, and cannot take rank as sub-class characters, except in the definition of the Dipnoi. Even then some of the orders are susceptible to adaptive modification, and thus do not present those sharp and fast lines of demarcation which are necessary for ordinal definition. To return to *Chimaera*, it is obvious that, so far as the concrescence of the palatoquadrate of the skull is concerned, this condition could readily be derived from that seen in the Notidani (*Heptanchus*) simply by fixation, and after carefully comparing all the other characters which are assigned by the author to give *Chimaera* and its allies a *sub-class* position, among the Holocephali, we find that they are no greater than those which give the Acanthodii and Pleuropterygii their *ordinal* position. Upon these grounds we conclude that the scheme of major classifica-

tion of the Fishes (page 27) is entirely unnatural, as it fails to set forth the phylogenetic relations of the Fishes, and confuses the student as to the types which are actually most nearly allied.

Passing to the Amphibia, it may be noted (p. 125) that among the chief distinctions of the Stegocephalia, the paired condyle is not mentioned. This is very important, because the condyle furnishes one of the only means of separating these animals from the Pareiasauria. Upon p. 142 the author gives a very clear conception of what at the present time appears to be the natural grouping of the Reptilia, but the tabular classification upon p. 141 hardly conforms with the conceptions there set forth. It appears to the reviewer evident that the Pareiasauria, with their solid skulls, entirely lacking temporal fossae (except perhaps in *Procolophon*), should be sharply set apart from the Anomodontia. As regards the use of the term Anomodontia in preference to Cope's "Theromorpha," it may be pointed out that it was originally defined and repeatedly used by Owen to include the Dicynodonts only, and it can scarcely be stretched to include the Theriodonts, with their complete dentition, and much less the Pareiasauria with no arcades at all. In the diagrams and subsequent treatment of the temporal arches, the lower arch is referred to as if it represented a concrescence of both upper and lower arches. This is certainly the case in the Ichthyosauria, but not so certainly in the other types. It appears undesirable to perpetuate Cope's term "Pythonomorpha," because Cope wholly failed to substantiate his claim in opposition to Owen, that these animals were in any way related to the Ophidia. Their entire structure tends to support the theory of Owen, Dollo, and Baur, that they branched off from well-defined Lizards quite independently of the Snake phylum.

Another surprising feature in this work is the entire absence of mention of the important group of Placodontia, animals which are ordinarily placed among the anomodont reptiles, fine examples of which are found in the British Museum. No reference is made either to *Aëtosaurus*, important and interesting because it shows the complete dermal armature of the Belodont type. It is important to note, however, that the author throughout his treatment of the Reptilia shows a very clear and critical perception of the relations of different types, and makes many original suggestions of value. While retaining *Belodon* among the Crocodilia, he strongly hints at its relations with the Dinosauria, as observed by Fraas, and one cannot compare the fine remains of *Belodon* and *Zanclodon* in the Stuttgart collection without being struck by the strong resemblance between the two.

It should be made clear, in closing, that the above discussion of the work has hardly left space in which to point out its many valuable qualities. It will find its way into every laboratory where Vertebrate Anatomy is being studied, and will serve to emphasise more strongly than ever the principle for which Huxley and Cope so long contended, that Vertebrate Anatomy is only comprehensible by the light of Palaeontology: that the only difference between the fossil and recent animal is that one has been dead longer than the other.

H. F. O.

The Rabbit. By J. E. HARTING. 8vo, pp. viii. + 256. Illustrations. London: Longmans, Green, and Co., 1898. Price 5s.

This volume of the "Fur, Feather, and Fin Series" is a welcome addition to the literature of natural history and field sports. It will readily find its place on the book-shelves of sportsmen and naturalists, and will be of much service to gamekeepers and others interested in this useful though mischievous rodent. Much ignorance prevails, even amongst those who ought to know better, regarding the habits and peculiarities of the rabbit, and the intricacies of the law in dealing with the drastic provisions of that ill-advised and dis-

appointing enactment, the Ground Game Act. All needful information can be easily got from Mr. Harting's book, which is well indexed. The author has also much to tell us about rabbits attacking stoats, carrying their young, swimming across water, barking and killing trees, and so on, but space forbids our entering on these topics. A list is given of ornamental shrubs for undercover which are asserted to be "rabbit proof," and which "will thrive under the drip of trees." This is invaluable, and all sportsmen should see that this volume is put into the hands of their foresters and gamekeepers.

Mr. Harting enlarges, we think unnecessarily, on rabbits biting. Few sportsmen are ever bitten, for the simple reason that they do not handle many maimed rabbits. It is otherwise with gamekeepers, who handle thousands in taking them out of traps, and we have more than once seen them severely bitten. Again, it is asserted that tame rabbits will not burrow. This is erroneous, for we once turned out a black and white doe in a sandy burrow, where for several years she reared many litters. When a ferret was put in, she always bolted at once, and on two occasions turned and attacked her pursuer when it came outside. Being tame, she never attempted to run far away, and was often witness to her progeny bolting from the ferret, and being shot.

On the price of rabbits Mr. Harting says—"Trapped or snared rabbits should realise, say, 2s. 9d a couple; shot ones, 2s. 8d. a couple." We should much like to know where these prices can be got, as we can undertake to send heavy weekly consignments.

In referring to stoats and weasels, we fear Mr. Harting panders to sentimentalists, for he "would not ruthlessly trap and kill every weasel and stoat on the warren," and he faithfully reproduces the old story, which we had regarded as exploded, about "improving the stock by killing the weakly ones." As a corroboration of his statements he refers to the vole plague of 1892, and says—"Beyond doubt the weasel is the natural enemy of field-mice, and no greater mistake can be made than to destroy the former when the latter are numerous, or threatening to become so." As with lemmings in other countries, there were plagues of voles long before the days of game preservation or the trapping of weasels, and we venture to affirm that these plagues will occur again. The voles attracted all kinds of enemies: short-eared owls gathered and bred in their midst, and "blackening trains" of rooks found abundant food. As in previous visitations, the plague suddenly disappeared as unaccountably as it came, and we fear that Mr. Harting's weasel theory will not hold water.

In treating of long netting, after describing the process of setting the net, Mr. Harting says: "One or more helpers, as the length of net may require, stays back to extricate the rabbits from the net, or to knock them on the head with a stick as they try to force their way through." Nothing can demonstrate more clearly that the author has never seen the long net used, and we fear his information has been acquired from an unauthentic source.

We have noticed these points, but it would be gross injustice to suggest that they outweigh, or even overshadow, the value of the work. It is a delightful book, and one of genuine usefulness. The illustrations are carefully done, and the whole form of the book does credit to the publishers.

TOM SPEEDY.

A STUDENT'S ASTRONOMY.

A New Astronomy. By Prof. DAVID P. TODD, M.A. Ph.D. 8vo, pp. 480, with figures. New York, Cincinnati, Chicago: American Book Company, 1898. Price 7s. 6d.

Prof. Todd is to be congratulated on having given to astronomical science a most valuable book, the need of which has certainly been felt by many teachers of elementary astronomy. There is nothing that tends so much to

promote a lively interest in the mind of the student as the practice of getting results from experiments of his own, and it is on this true principle that the author has based a great part of his work. Wherever possible, he suggests practical observations which, while requiring only the simplest instrumental equipment, naturally lead to a clear comprehension of the problems. The author's explanations are adapted to beginners, and the student is taught throughout to think for himself, instead of simply burdening his memory with disconnected data. It is safe to say that any one who will carefully follow this able guide, will become acquainted not only with the most interesting results of astronomy, but also with the methods which are required to deduce these from observation. An extensive series of original illustrations form a valuable feature of the book, which can be cordially recommended to all who are interested in the teaching of astronomy.

J. HALM.

EXPERIMENTAL CYTOLOGY.

La Cytologie expérimentale. Essai de cytomécanique. By ALPHONSE LABBÉ, Docteur ès Sciences, conservateur des collections de zoologie à la Sorbonne. 8vo, pp. viii and 187, with 56 figures. Paris: Carré et Naud, 1898. Price 5 francs.

As every biologist knows, cytology has ceased to be merely observational, and has become definitely experimental. But the literature embodying the advances which have been made by this new departure is scattered, and in some cases not very accessible. Hence the value of this compact little book, which supplies a clear and terse introduction to the subject, which may be read at a sitting. Dr. Labbé, who has himself made some valuable contributions to cell-lore, has here brought together illustrative examples of the most important concrete results of recent work on the influence of environment upon the cell, the inter-relations of nucleus and cytoplasm, "tropisms" and "tactisms," experimental embryology, and the like. There is no attempt at exhaustive treatment, which would have spoiled the book, and there is an unusual reserve of speculative suggestion, which is probably also wise. The book aims at being a student's introduction to the facts of the case, and as such it is admirable.

J. A. T.

BIOLOGICAL LITERATURE OF SERVIA.

It is not generally known that Servia possesses four media of scientific thought. Two of these are found in the Srpska Kral'evska Akademija, of Belgrade, which publishes proceedings called *Ghlasa* in octavo, and *Spomenik*, transactions, in quarto. The word Ghlasa corresponds to the German Nachricht and Spomenik to the German Denkschrift. Both have been running since about 1888. The third is *Nastavnik*, the organ of the Servian professional society, a journal similar to the now defunct *Science Progress*, consisting of original articles only; while the fourth and last is *Delo*, or Journal of Literature and Science. A set of the first three, in so far as they pertain to mathematical and biological matter, has recently been received by the British Museum (Nat. Hist.).

RECENT LITERATURE ON THE FORAMINIFERA.

Among the noteworthy papers which have recently appeared are two which represent the first efforts of Croatian and Servian zoologists to deal with the subject. One of these papers, by Velimir Dezelic, is entitled "Foraminifera jadranskoga mora," deals with the Foraminifera of the Adriatic, and was published in the ninth volume of the *Glasnik Hrvats Narod. Drustva*, in 1896. Unfortunately we have not yet seen it. The other is a paper by P. S. Pavlovic,

"Prilogh poznava'u Foraminifera iz II. Mediteranskikh slojeva u Srbiji," and was published in the *Ghlasa Srpske Kral'evske Akademije*, pt. lvi. 1898. This deals with the Mediterranean deposits near Belgrade, and figures are given of some interesting Frondiculariae. Another paper is by Detlev Lienau of Königsberg, and reads "Fusulinella, ihr Schalenbau und ihre systematische Stellung" (*Zeitschr. Deutsch. Geol. Ges.* 1898). Dr. Lienau comes to the conclusion that *Fusulinella* is a true calcareous Foraminifer, and that it does not belong to the Endothyridae, as stated by Neumayr and Rhumbler. An elaborate paper has also recently appeared in *Palaeontographica*, vol. xliv., by Dr. Schellwein, dealing with the Alpine *Fusulina* limestone. Numerous forms are figured and described, falling into many new species. Eight plates accompany the text, of which six represent the genera *Fusulina* and *Schwagerina*. A general paper, by Charles Upton, on "Chalk under the Microscope" (*Proc. Cotteswold Nat. Field Club*, vol. xii. pt. 3, 1898), treats of the contents of a piece of upper chalk from Purley, and is accompanied by an excellent plate of various forms.

"The Lower Cretaceous Gryphaeas of the Texas Region." By R. T. HILL and T. W. VAUGHAN. (*Bull. U.S. Geol. Surv.*, No. 151, 8vo. 1898). Pp. 66, 35 pls.

This paper treats of the species, stratigraphical occurrence, and relationships of one particular group out of the many kinds of fossil oysters found in the lower cretaceous formations of Texas. The group includes those forms which have been referred to *Gryphaea pitcheri*, Morton, and is of great importance owing to the assistance which a knowledge of the forms composing it renders in determining the true horizon of certain beds in geological sections.

Unfortunately inadequate descriptions based upon imperfect specimens, the true horizons of which had not been recorded, coupled with the loss for a long period of the type specimen of *G. pitcheri*, Morton, resulted in a fearful confusion of nomenclature, and gave rise to much controversy both as to the species and the beds in which it occurred.

From this condition of chaos the authors of this most carefully written memoir have extricated the subject. They show that under *Gryphaea pitcheri* no less than eight species have been included, and amongst them the familiar upper chalk *G. vesicularis*. Six members of the group, including two new species, belong to the lower cretaceous. The type species itself proved to be identical with *G. corrugata*, Say, which name consequently stands.

All these forms are fully described and figured, their geological distribution and probable phylogeny is traced, and the only point which a preliminary investigation suggests as wanting is some allusion to the late Félix Bernard's papers on the morphology of the hinge when dealing with the nepionic stage of *G. Washitaensis*. This last-named species, by the bye, calls to mind the well-known *G. vesicularis* of the upper cretaceous, both of Europe and America, and was doubtless its lineal ancestor. Many of the lower cretaceous forms here figured present apparent affinities to European species, though how far, if at all, the authors have studied the latter does not appear.

Anyhow much more work remains to be done on this difficult group of Ostreidae before satisfactory conclusions can be reached concerning them. To begin with, as the authors point out, "nearly all of the species of fossil oysters have been founded upon adult forms, without knowledge of the life-history of the individual. . . . It is regrettable that full suites of specimens representing all the species hitherto described have not been studied." In contradistinction to accepted authorities the observations of the writers of this monograph lead to the conclusion "that certain forms of the Ostreidae possess very distinct specific characters, have definite geologic horizons, and are $(BV)^2$ of the greatest value in stratigraphic work."

The authorities of the British Museum do not send out their "Catalogue of Birds" for review, but we must notice the completion of this great undertaking by the recent publication of volume xxvi. by Dr. Bowdler Sharpe and Mr. W. R. Ogilvie Grant. This is really the twenty-seventh volume issued since the work was begun twenty-five years ago. This catalogue, prepared by eleven authors and edited by Dr. Bowdler Sharpe, gives an account of 11,614 species belonging to 2255 genera and 124 families. Such additions and corrections as may be necessary will be published in supplementary volumes.

The Geological Society of London has undertaken the publication of the manuscript in its possession of a portion of the third volume of Hutton's "Theory of the Earth." This volume, edited by Sir Archibald Geikie, will be printed in the style of the first and second volumes of the same work, and will contain about 300 pages. It will be issued in paper covers. The price to the public is 3s. 6d., and as only a limited number will be issued, intending purchasers should apply at once to the Secretary.

As No. 25 of its publications, the Geological Survey of Norway has issued a geological map, with description by K. O. Bjørlykke, of Christiania and environs. This reproduces in more popular form the recent researches of Kjerulf and Brøgger, and may be of some use to the geologically-minded tourist. This Survey has also issued an account of its exhibits at Bergen in 1898, with which are combined articles of more permanent value on the Geological survey, the mining, and stone industry of Norway.

The first number of *Science Work*, the advent of which was noted in *Natural Science* for January, is chiefly noticeable for its list "of the leading contents of recent scientific magazines and periodicals"; the list is classified under the various sciences. For some reason the names of most of our own contributors are misspelled; indeed misprints of like nature are not rare throughout. Useful features are the first instalments of a "Directory of Local Societies" and a "Directory of Lecturers." The editor, Mr. Waller Jeffs, evidently means to make this new venture as successful as his firmly established journal, *Business*.

In the *Verhandlungen der russischen mineralogischen Gesellschaft*, 1898, Bd. xxxv. pp. 1-54, Th. Tschernyschew has a paper on the fossil sponges from the Permo-Carboniferous (Artinsk) and Carboniferous beds of the Ural and Timan. The paper, which is in German, is well illustrated by five plates and many figures in the text, mostly photographic. The sponges belong to the genera *Pemmatites*, *Kazania*, *Haplistion* (?), and *Stuckenbergia*, the last being new. In the sponge-fauna, as well as in other characters, the author finds a resemblance between the Artinsk beds and the upper horizon of the Permo-Carboniferous rocks of Spitzbergen, the *Productus*-bearing chert.

The Palaeontographical Society's volume for the year 1898 has just been issued, and contains—The "Palaeozoic Phyllopoda," Part III., by Professor T. Rupert Jones and Dr. H. Woodward, with 8 plates; the "Carboniferous Lamellibranchiata," Part III., by Dr. Wheelton Hind, with 10 plates; the "Inferior Oolite Ammonites," Part X. (Supplement No. I.), by Mr. S. S. Buckman, with 4 plates; the "Carboniferous Cephalopoda of Ireland," Part II., by Dr. A. H. Foord, with 10 plates; the "Devonian Fauna of the South of England," Vol. III. Part III., by the Rev. G. F. Whidborne, with 17 plates. The volume for 1899 is in preparation, and will contain the commencement of a new monograph on the "Mollusca of the Cretaceous Formations," by H. Woods.

OBITUARIES.

G. H. THEODOR EIMER.

BORN 22ND FEBRUARY 1843; DIED 29TH MAY 1898.

DR. G. H. THEODOR EIMER, Professor of Zoology and Comparative Anatomy at Tübingen, was born at Stäfa, in the Canton of Zürich, where his father was district medical officer. His earliest years were passed at Freiburg, in Breisgau. At twelve years of age he entered the Gymnasium of Bruchsal. On leaving the Gymnasium he became a student in the medical faculty of the University of Tübingen, where he was in zoological subjects a pupil of Leydig. In 1863-64 he studied at Freiburg, in 1864-65 at Heidelberg, and in the latter year passed the examination in Natural Science at Karlsruhe. In the following winter he was again at Tübingen, and thence he went to Berlin to study the practical subjects of medicine. During the two years he was at Berlin he came much under the influence of Virchow. He graduated at the German metropolis in medicine and surgery in 1867, and in the following year passed the state examination at Karlsruhe. He had formed the resolution of devoting himself to research instead of practising the medical profession, and, on the advice of Virchow, went again to Freiburg to work in Weismann's laboratory. Here his interest in the problems of evolution, already aroused, was strongly developed, and he commenced the investigations which led him to views in many respects diametrically opposed to those of his teacher. In 1869 he acted as Prosector of Zootomy to Kölliker in Würzburg, but in 1870 he gave up academical pursuits for a time, and the day after his marriage set out with his bride for the seat of the Franco-German war. He took part in the campaign as volunteer field-surgeon, while his wife was a volunteer field-nurse. The hardships of the campaign enfeebled his health, and in 1871 he went to Italy to recuperate. During this and subsequent visits to Italy he carried out his well-known researches on Medusae and other marine forms, and on the variations of the lizard. On his return to Würzburg in 1871 he set up as privat-docent in zoology. In 1874 he became Inspector of the Grand Ducal Museum at Darmstadt, and Professor of Zoology at the Polytechnic High School of that city, and in the following year was invited to succeed Leydig as Professor of Zoology at Tübingen in the University in which he commenced his academical career.

Although he made various contributions to histology and other subjects, Eimer's most important investigations are those which deal with problems of evolution. He has taken a prominent part in the tournaments waged over these questions during the last two decades. Not entirely neglecting other phenomena, he gave his attention principally to the external characters which distinguish species and genera from one another in various groups, and has contributed powerfully to the growing conviction that such characters are not to be explained on the principle of simple utility. In his work on *Lacerta muralis*, and his papers on the markings of mammals published in "*Humboldt*" between 1878 and 1888,

he pointed out the evidence that changes in markings occur in a definite order, and are excited by change of conditions. He was strongly convinced that variation occurs, not in all directions, but in a limited number of definite directions, in other words that the direction of variation is largely pre-ordained by the constitution of the organism. In 1888 he published a summary of his facts and conclusions under the title "Entstehung der Arten, auf Grund vom Vererben erworbener Eigenschaften, nach den Gesetzen organischen Wachsens." He followed this up by works on the characters of butterflies, in which he elaborated his method of investigation in great detail. The first of these, in two parts (1889 and 1895), referred to the species of the genus *Papilio*, and allied forms. His latest work, "Orthogenesis der Schmetterlinge," was published in 1897, and contains a mass of important and interesting detail.

Eimer's powers of lucid exposition were not perhaps of the highest order, and his methods of controversy were often too personal and passionate. But on the other hand his researches are very original, penetrating, and illuminating, and his bitterness, however much to be regretted, was not unnatural. It is unlikely that the laws he was fond of formulating will prove to be of general application, but his investigations of diagnostic characters, as for example in the case of leaf-like butterflies, bring to light important phenomena whose significance had not previously been perceived, and he has left behind him a body of work which will be of permanent value in the pursuit of one great object of biological research, namely, the discovery of the particular causes of the characters of organisms. J. T. C.

The deaths are also announced of Mr. JOHN BARROW, F.R.S., who died in Dec. 1898 at the age of 91—he took a leading part in promoting the search for Sir John Franklin; on May 13, 1898, at Stockholm, Dr. SVEN BORGSTRÖM, bryologist, aged 72; Dr. THOMAS SANDERSON BULMER, by suicide, at Sierra Blanca, Texas, on Oct. 5—a student of American archaeology and ethnology; on Aug. 14, 1898, at Taftville, Conn., Prof. JOHN COMFORT FILLMORE, ethnologist, of Pomona College, California; CAMILLE FLAGEY, lichenologist, in Algiers, aged 62; JOSEPH GIBELLI, Professor of Botany at Turin University; the entomologist, LOUIS A. GLASER of New Brighton, at Mannheim, Germany; on Dec. 21, ALFREDO ANTUNES KANTHACK, Professor of Pathology in Cambridge University, aged 35; Mr. CHRISTOPHER YOUNG MICHIE, a leading Scottish authority on forestry, author of *The Larch*, *The Practice of Forestry*, etc.; on Oct. 23, Dr. HERMANN MÜLLER, privat-docent for bacteriology at Vienna, aged 32; JACQUES PASSÉ, an assistant in the laboratory of physiological psychology at the Sorbonne, well known for his researches on the sense of smell; Dr. AUGUST POLLMANN, teacher of agriculture at the Agricultural Academy, Bonn, on May 16, 1898, aged 85; on Aug. 6, at Irrenhaus, EMERICH VELLAY, formerly assistant at the Hungarian entomological station; G. VENTURI, the Austrian bryologist, on June 5, 1898, bequeathing his moss herbarium and library to the city of Trent; on Jan. 15, Mr. ANDREW WILSON, L.D.S., late Vice-President of the Royal Physical Society, Edinburgh —an expert odontologist and an enthusiastic student of Mammalian dentition and Lepidoptera. We regret also to have to announce that Dr. Henry Alleyne Nicholson, Professor of Natural History in the University of Aberdeen, died after a short illness, on January 19, at the age of fifty-five. An obituary notice will be given next month.

CORRESPONDENCE.

THE AUTHORSHIP OF ILLUSTRATIONS.

THE very just note in your December number, pp. 365-367, leads me to ask, Where does the artist come in, supposing he is not the author? Walker, years ago, described some Diptera in a more or less unintelligible manner; but Westwood prepared the illustrations, which were very excellent, and served for the recognition of the species. Now should these illustrations be credited to Walker? Ashmead, in the *Canadian Entomologist*, 1898, p. 309, has the following note—"*Allomorpha* [a genus of saw-flies] may be wrongly placed in my table. Cameron says nothing about the venation of the hind wings. His description reads—'Alar neuration resembles *Strongylogaster* (*Cingulatus* group).' Now, *S. cingulatus* has two discal cells in the hind wings. Kirby, however, who, I believe, examined the type, says—'*Hind wings with one discal cell.*' The artist, however, employed by Kirby has figured it on Plate X., No. 22, *without a cell in the hind wings!* In my perplexity I have followed the artist, since I find his figures of saw-flies known to me perfectly accurate."

Now, if the artist referred to by Ashmead is better authority than Kirby or Cameron, so that when a difficulty arises his figure is assumed to be correct rather than their descriptions, does he not deserve to be quoted as an author? Of course, the artist does not necessarily possess any technical or critical knowledge of the objects he draws, nor can he be made responsible for the labelling of his figures. At the same time, it is probable that if the scientific artist received more recognition for his work, that work would be better done. I do not think that at present we always treat him fairly.

T. D. A. COCKERELL.

MESILLA PARK, NEW MEXICO, U.S.A.

TELEGONY.

SIR—After a careful study of the facts already ascertained regarding telegony—that peculiar phenomenon of cross-breeding, popularly termed "throw-back"—we see that these can be attributed to reversion with almost as much likelihood as to telegony. Nevertheless, we feel assured that telegonic effects are sometimes shown by the offspring; and as this question is of the highest importance to any theory of heredity, we seek through your columns to extend our appeal for co-operation in experiment, and suggest the following:—

A female of a wild species (*e.g.* the wild rabbit) should first bear young to a male of a domesticated breed of the same species (*e.g.* the Angora rabbit), and then to a male of her own breed. If, then, the progeny of this union were to show any traces of the first union, they must be due to telegony; for, of course, no type can revert to one more differentiated than itself. Birds might be experimented on in a similar way, the first crosses being, *e.g.*—the "barn-door" cock—pheasant hen; a domesticated drake—wild duck.

We are ourselves conducting as many experiments as we can, but telegony is without doubt of extreme rarity, and the more trials that are made the greater is the chance of success. Those who will assist are asked if they will kindly send the skins of those parents and young which display telegony; also, in the case of birds, to send an egg out of each batch.—We are, etc.,

ALEX. MEEK.

DURHAM COLLEGE OF SCIENCE, NEWCASTLE-ON-TYNE.

G. P. BULMAN.

CULLERCOATS, NORTHUMBERLAND.

NEWS.

THE following appointments have recently been made:—Elmer D. Ball, to be assistant entomologist at the Colorado Experiment Station; Dr. J. Behrens, of Carlsruhe, to be bacteriologist to the newly-founded biological section for agriculture and forestry at Berlin; J. P. Blanton, to be president of the University of Idaho, and director of its Experimental Station; Dr. L. Bordas, to be chief of zoological work in the faculty of science at Marseilles; Antonio Borzi, to be professor of zoology and comparative anatomy at Palermo University; Mr. Thomas Bowhill, F.R.C.V.S., author of "Manual of Bacteriological Technique," to be bacteriologist to the Glamorgan County Council; Karl Brischke, as director of the Botanical Garden in Thorn; C. W. Burkett, to be associate professor of agriculture at the New Hampshire College; Dr. John M. Clarke, to be state palaeontologist of New York; Dr. Dannenberg, to be professor of mineralogy and geology at the Mining Academy in Clausthal; Prof. J. R. Ainsworth Davis, as additional examiner in zoology in the University of Edinburgh; Dr. Rudolf Disselhorst, to be professor of animal physiology at Halle University; Dr. Eugen Dubois (*Pithecanthropus*), to be professor of geology at Amsterdam University; Dr. E. P. Felt, to succeed the late J. A. Lintner, as state entomologist of New York; M. T. French, to be professor of agriculture at Idaho College and Experimental Station; Max von Frey, from assistant professor to full professor of physiology at Zürich University; Mr. Gravier, to be assistant in the Paris Museum of Natural History in the place of the late Félix Bernard; Dr. D. Frazer Harris, to be lecturer in physiology at St. Andrews University; Dr. Hettner, of Tübingen, to be professor of geography at Würzburg University; Dr. G. Bertram Hunt, as assistant in the department of pathological histology at the University of London; Dr. Ernst Kalkowsky, to be director of the mineralogical, geological, and archaeological collections at Dresden; Dr. Klockmann, of Clausthal, to be professor of mineralogy and geology in the Technical Institution at Aix; Dr. Kolkwitz, to be professor of histology at Innsbruck University; Dr. Casimir Kwietniewski, as assistant in the cabinet of zoology and anatomy at Messina University; Dr. Lambert, as assistant at the plant-physiology experimental station in Geisenheim; Dr. Lepetet, to be professor of histology in Clermont University; Dr. James Little, as Regius professor of medicine in Dublin University; Alberto Löfgren, to be director of the botanical gardens at São Paulo, Brazil; Charles P. Lounsbury, of Amherst, Mass., as government entomologist at Cape Town; Dr. R. Stewart MacDougall, as examiner in agricultural entomology in the University of Edinburgh; Dr. de Marignac, to be professor of hygiene at Geneva University; Dr. F. J. H. Merrill to be state geologist of New York, the palaeontologist work being taken by Dr. Clarke (see above); A. S. Miller, to be geologist to the Idaho Experiment Station; Dr. M. von Minder, as assistant in botany at Giessen University; Dr. Heinrich Obersteiner, to be full professor of the physiology and pathology of the central nervous system at Vienna University; C. S. Parsons, as director of the Arizona Agricultural Experiment Station

in Tucson; Prof. G. Perroncito, as director in the Royal Veterinary School of Turin; Dr. G. N. Pitt, of Guy's Hospital, as examiner in medicine at Cambridge University; Dr. Fritz Roemer, of Jena, as assistant in the zoological department of the Museum für Naturkunde, Berlin; Dr. D. Saccardo, to assist Prof. F. Morini in the botanical garden of Bologna University: W. G. Savage, M.B., as assistant in the department of bacteriology at University of London: Dr. Fritz Schaudinn, as privat-docent for zoology in Berlin University; Dr. Schroeter, as privat-docent for botany in Bonn University; Dr. L. S. Schultze, as assistant at the Zoological Institute of Jena University; Dr. Carl Freiherr von Tubeuf, of Munich, to be director of the botanical laboratory in the Biological Experiment Station for Agriculture and Forestry at Berlin; J. A. Thomson, as additional examiner in zoology in the University of Glasgow; Alexandro Trotter, as assistant in the botanic garden of Padua; Dr. R. Wagner, of Munich, as assistant in the Institute for Vegetable Physiology at Heidelberg; Dr. Karl Wehmer, to be professor of mycology at the Technical College in Hannover; Dr. N. Wille, to be curator of the Museum and Herbarium of the University of Christiania; Jas. Withycome, to be assistant director and agriculturist of the Oregon Experiment Station; Dr. R. W. Zimmermann, to be professor-extraordinarius of anatomy at Berne University; Dr. Oskar Zoth, to be professor-extraordinarius of physiology at Graz University.

Among the New Year's honours we notice a baronetcy for the surgeon Sir Sir Henry Thompson. Prof. W. C. Roberts Austen, of the Mint, is promoted to be K.C.B., and Mr. Thiselton Dyer, the director of Kew Gardens, to be K.C.M.G., in recognition of services rendered to Colonial Governments. Pure science, it will be seen, meets with no recognition, yet see *Natural Science*, vol. xiv. p. 1.

Mr. William Christopher MacDonald, merchant, of Montreal, has received the honour of knighthood in recognition of his gifts to educational and philanthropic objects in Canada. He is said to have given to M'Gill University about 1,600,000 dollars in all.

The Royal Academy of Sciences, Stockholm, has awarded its Linnaeus medal to Mr. J. Stadling, in recognition of his journey through Siberia and a gift of fish from that country.

On occasion of the Jubilee of the St. Petersburg Academy of Medicine, the following British scientists have been appointed honorary members of the Academy: Sir William MacCormac, Sir William Turner, Lord Rayleigh, Sir William Stokes, Drs. William Macewen, Thompson, and Branston.

The Council of the Royal Institute of Public Health has awarded the Harben Gold Medal for 1899 to Lord Lister, P.R.S., in recognition of his eminent services to preventive medicine; and it has appointed Professor William R. Smith, M.D., D.Sc., as Harben Lecturer for the year 1899; he has chosen "Diphtheria" as his subject.

Sir John Lubbock has been elected a member of the Royal Society of Science at Upsala.

During the past year the total number of matriculated students attending the University of Edinburgh was 2813, including 211 women. Of this number 817 (including 190 women) were enrolled in the Faculty of Arts, 147 (including 5 women) in the Faculty of Science, 63 in the Faculty of Divinity, 373 in the Faculty of Law, 1387 (including 6 women) in the Faculty of Medicine, and 26 (including 10 women) in the Faculty of Music. Of the students of medicine, 584, or over 42 per cent, belonged to Scotland; 374, or nearly 27 per cent, were from England and Wales; 94 from Ireland, 60 from India, 231, or fully 16½ per cent, from British Colonies; and 44 from foreign countries.

The Regents of the University of the State of New York have decided to divide the work in geology and palaeontology, which was for so many years in charge of the late Professor James Hall, and in so doing have erected two co-ordinate departments, one of palaeontology and stratigraphic geology and the other of "pure geology," the latter to cover dynamic and physical geology, the crystalline rocks, superficial geology, etc. Some of the changes are noted in our list of appointments.

Science announces that Dr. Thomas Egleston, emeritus professor of mineralogy and metallurgy in Columbia University, has presented the university with his library and mineralogical collection, the latter containing about 5000 valuable specimens.

We learn from the *American Naturalist* that the biological and geological departments of the Massachusetts Institute of Technology have moved into new and more spacious quarters in the Pierce building recently erected.

The King of Sweden and Norway has given the Swedish Academy of Sciences the sum of about two hundred guineas for continuing the investigation of Swedish seas under the direction of Professor Pettersson. During the present year it is intended to continue the soundings in the Baltic and Gulf of Bothnia, and the continuous observations in the Skagerrak; also to investigate the conditions on the northernmost parts of the North Sea plateau, where is the fishing-ground of the Swedish bank-fishers, and the conditions during the months of October and November, after the close of the herring-fishery.

The Royal Academy of Medicine of Belgium proposes to ask the Belgian government to enter into negotiations with foreign governments, with a view to drawing up an International Pharmacopoeia.

The awards of the Geological Society of London for the year 1899 will be as follow:—Wollaston Medal, Charles Lapworth; Wollaston Fund, J. B. Harrison, of British Guiana; Murchison Medal (this year awarded twice), Benjamin N. Peach and John Horne; Murchison Fund, James Bennie; Lyell Medal, General C. A. M'Mahon; Lyell Fund, divided between Frederick Chapman and John Ward; Bigsby Medal, T. W. Edgeworth David, of Sydney.

The gold medal of the French Geographical Society has been awarded to Mr. Gentil for his explorations in the neighbourhood of Lake Tchad.

The Seventh International Geographical Congress is to meet in Berlin from Thursday, September 28, to Wednesday, October 4, of this year. The subscription for members is £1. All who wish to contribute papers are requested to give notice before April 1, and to send their MS. by June 1; abstracts, if desired, should not exceed 1500 words, and must be sent in before August 1. Motions to be laid before the Congress should be sent in not later than June 1. The languages admitted at the Congress are English, French, German, and Italian. All correspondence is to be addressed to 90 Zimmerstrasse, Berlin, S.W.

The Committee of the International Geological Congress, 1900, which will meet at Paris, has just issued, through the Minister of Commerce, Industry, etc., the first circular. The Congress will take place from the 16th to the 28th August 1900, after which will follow these excursions:—Tertiaries of the Paris basin (2 days); the Boulonnais and Normandy (10 days); the central massiff (10 days); the Ardennes (8 days); Picardy (6 days); Brittany (10 days); Mayenne (8 days); the turonian of Touraine and the cenomanian of Mans (6 days); Touraine (4 days); Morvan (10 days); coal-measures of Commentry and of Decazeville (7 days); Mont Dore, chaîne des Puys and Limagne (10 days); Bharentes (8 days); Bordeaux basin (6 days); Tertiaries of the Rhône and the Casse-Alps (8 days); Dauphiné and Mont Blanc (10 days); Hautes Alps (10 to 12 days); Monts Ventoux and de Lure (10 days); Basse-Provence (10 days);

le Montagne Noire (8 days); Pyrenees (10 days). A special geological guide will be ready early in 1900; meanwhile English geologists will remember the excellent "Geology of the Paris Basin," by Messrs. Harris and Burrows, published by the Geologists' Association of London.

The new president of the Anthropological Society of Paris is Dr. Capitan.

The new president of the American Microscopical Society is Dr. William C. Krauss, of Buffalo, N.Y.

The New York Zoological Society has issued No. 3 of its News Bulletin. This is illustrated with four large photographic figures, showing the works at present in progress. A great deal seems to have been accomplished since the summer, and it is hoped to have the Park partially stocked with animals, and open to the public, by May next.

It is announced that those interested in promoting Zoological Gardens in Edinburgh have fixed their eyes provisionally on a site in the neighbourhood of Barnton. As we pointed out before, the only hope of success, in default of abundant capital, is to choose a site in some habitual resort of holidayers, and this consideration points to Portobello rather than to Barnton.

The President of the American Society of Naturalists, at its New York meeting in December 1898, delivered an address on "Reform in Medical Education." This is published in *Science* for December 30. Eleven other scientific societies were meeting during the same period.

The Excursion Secretary of the Geologists' Association, London, is now Mr. F. Meeson, 29 Thurloe Place, South Kensington. He is trying to organise some cycle excursions.

The "At Home" of the President and Council of the Geological Society, London, on December 15, was attended by a large number of Fellows. With the aid of the lantern Mr. H. W. Monckton showed photographs of the glaciers and fjords of the Bergen district, Norway, and Mr. C. W. Andrews showed his photographs of Christmas Island. There were many interesting exhibits. The Director-General of the Survey produced markings from the Silurian rocks of Tipperary, simulating shells, graptolites, and fucoids, but probably due to inorganic causes. Mr. Whitaker exhibited a geological map of London and suburbs made in relief on stamped tin by J. B. Jordan. Mr. Etheridge exhibited cores from the Brabourne borehole in South-East Kent; this has now reached a depth of 2003 feet in Lower Carboniferous rocks.

Mr. Monckton redelivered the above-mentioned lecture to the Geologists' Association, London, on January 6.

The Preston Scientific Society held its annual meeting on November 23, 1898. It was announced that during the year the number of members had increased from 520 to 710. This being so, it is the more to be regretted that the Corporation should have found itself unable to continue to permit the Society the use of its rooms in Cross Street, causing the Society pecuniary loss, and the trouble of furnishing new rooms at 119A Fishergate. The collections of the Society are growing. Miss Robinson has presented a large collection of British Plants; while a series of local land and fresh-water mollusca has been given by Messrs. R. Garbet and W. H. Heathcote. The syllabus of lectures and sectional meetings for the current session is remarkably full, but contains rather a larger proportion of lectures on general subjects than we like to see in the case of an actively working local society. The new president is W. E. M. Tomlinson, M.P.; and the secretary is W. H. Heathcote, 47 Frenchwood Street, Preston.

The retirement of Sir John Evans from the treasurership of the Royal Society, after a period of service of twenty years, has seemed a fitting opportunity for

the Fellows of the Society to give expression to their sense of obligation for the efficient manner in which he has discharged the arduous duties of his office. There is a consensus of opinion that the most suitable form for marking appreciation would be a portrait painted in oil colours. This would find an appropriate place on the walls of the Society's apartments at Burlington House, where Sir John Evans has for many years past spent a considerable proportion of his time in carrying on the work of the Society. Subscriptions from Fellows of the Society will be received by the assistant secretary.

At a meeting of the Royal Physical Society of Edinburgh, on January 18, the following communications were read:—On the genesis of some Scottish minerals, part i., by Mr. J. G. Goodchild; on the minute structure of the so-called "rectal" gland of the skate, by Dr. John Crawford; and on spiders of the Edinburgh district (190 species now recorded), by Mr. W. Evans and Mr. G. H. Carpenter. Mr. Crawford contrasted the structure of the "rectal" gland with that of the appendix vermiformis, and noted especially the remarkable disposition of the vascular supply. A glycerine extract gave no evidence of digestive function.

At the Royal Victoria Hall, Waterloo Bridge Road, London, the following penny science lectures were delivered during January:—Rev. R. H. Whitcombe, "Science Jottings in Switzerland"; Mr. R. A. Gregory, "Astronomy before Telescopes"; Prof. Farmer, "Plants as Engineers"; Mr. C. W. Andrews, "Christmas Island"; Prof. Frank Clowes, "Old Father Thames."

During the present term Mr. A. G. Tansley is giving a course of about thirty-three lectures on the morphology and histology of the vascular system of plants at University College, London. Each lecture is followed by two hours' practical work.

The conflagration which recently broke out in the physical laboratory of the University of Geneva destroyed Prof. Chodat's botanical collection, together with 200 drawings by the professor, which were the result of ten years' labour.

In an article in the *Glasgow Herald* of January 7 Dr. Robert Munro refers to an article on the marine structure recently discovered in the estuary of the Clyde, which appeared in the November number of *Natural Science*, and in which his name is introduced as one who, after making a thorough investigation of the site, "declared it was the most curious, puzzling, and interesting find of the kind he had met with in all his long experience, and, so far as he knew, unique." From the general purport of that article the public may have supposed that the opinions there promulgated as to the age, structure, and marvels of the Dumbuck crannog have been endorsed by Dr. Munro. But this is not so, as he regards it neither as a pile-structure nor as a monument of Neolithic times. In attempting to solve the riddle of the remarkable art gallery—idols, amulets, and ornaments of shale and shell—there are two alternative conclusions to be formulated. Either these objects are what the investigators assert them to be, the genuine relics of the inhabitants of the fort and crannog, or they are not. On the former hypothesis they form the most remarkable collection of archaeological remains ever found in Scotland. On the latter, they are the productions of some idle practical joker.

Dr. Munro wishes to state that he has not the slightest clue to the *provenance* of the relics whose genuineness he calls in question, as his opinion is based entirely on their inherent character and total variance with all other archaeological remains known to him.

Dr. F. P. Moreno, of the La Plata Museum, exhibited at the Zoological Society of London, on January 17, a fragment of the skin of the animal described by Ameghino as *Neomylodon*. The piece was about 18 inches across either way. Dr. Moreno and Professor Seeley maintained that the fragment was probably a portion of a *Mylodon* which had been preserved under similar con-

ditions to the Moa skin and feathers of New Zealand. Prof. Seeley compared it with the skin of *Rhinoceros* and *Elephas* found in the tundras of Siberia, skin which he emphatically stated had never been found in frozen soil or in masses of ice. With this statement the meeting distinctly disagreed. The general opinion of those zoologists present, on the main question, however, was that the skin exhibited was not that of a fossil, but of a recent, or comparatively recent, animal. The fragments in Ameghino's possession Dr. Moreno believes to be from this identical portion of skin, and if that be so, then English zoologists will have little doubt in deciding that Ameghino is correct in assigning the discovery to a new form, named by him *Neomylodon*.

Although the Apothecaries' Society has decided to abandon the management of the Chelsea Physic Garden, it will not disappear under bricks and mortar. The control is to be vested in the Trustees of the London Parochial Charities, but it will be managed by a committee of fifteen, including representatives of the Royal Society, the Technical Education Board, the Society of Apothecaries and the Royal College of Physicians in turn, the Pharmaceutical Society, and the Senate of the University of London. The existing garden will be maintained, rooms provided for lectures and experimental teaching, and a physiological laboratory may be erected. An income of £800 is to be provided by the Trustees, and other sums will be provided to carry out all the details of the scheme. Instruction will be provided, material supplied for teaching, and the Royal College of Science teachers and students will be allowed the use of the garden and rooms.

We alluded in our last number to Mr. Frederick W. Christian's explorations in the Caroline Islands. *The Times* states that Mr. Christian stayed nearly three years in Samoa, studying the language and customs of the people, especially those farthest removed from the settlements of the white man. In Tahiti and the Marquesas he spent two years, minutely noting down the language, the genealogies, folklore, and traditions of the inhabitants. He visited single-handed Spanish Micronesia, in order to obtain some further and minuter information upon certain mysterious ruins reported to exist upon Bonate, or Ponape, and Lele, two islands lying further to the eastward of the extensive Caroline chain. Here he obtained some 150 photographs in the districts of Kiti, U, Metalanim, Not, and Chokach (wrongly styled Jekoits and Jokoits in the present charts). The walled islets of Nan-Matal were explored and mapped out fairly accurately. The phonesis of very many native names and their spelling were changed from a meaningless jargon to their correct native renderings and accompanying significations. He also made excavations in the central vault of the sanctuary of Nan-Tanach, bringing to light a considerable number of curious tools, implements, and shell ornaments of an ancient date. Many of the old native legends and fairy tales were rescued from oblivion. Some new information was obtained about the flora and marine life of the archipelago. The former presence of an early Negrito race, conquered and absorbed or overlapped by later waves of Polynesian, Malayan, and Melanesian immigrants was fairly established. Also evidence was collected as to the obtrusion of many Japanese words upon the Micronesian area. Mr. Christian spent three months on Yap, in the Western Carolines, where he found ancient platforms and burial-places of Japanese design. He proposes to revisit the Caroline and Marianne Islands, especially Ruk, Tinian, Saipan, Pulawat, and Nuku-Oro, also the Pelew Islands.

C. F. Baker, of the Alabama Experiment Station, left on January 1 for a collecting trip of a year and a half's duration in South America.

Prof. Alexander Agassiz is said to have gone to Rhodesia to investigate its mineral resources. It is safe to say that he will not confine his attention to these.

The U.S. Fish Commission steamer "Fish Hawk" has gone to Porto Rico for the winter. The party it carries will, says *Science*, make a careful study of the various forms of life in the waters about the island, and incidentally the fauna and flora of the land will be studied and collections made in various branches of natural history. The material will be submitted to specialists, and their united papers will form a comprehensive report on the natural history of the island. Professor B. W. Evermann is in charge, and he will be assisted on the part of the Fish Commission by Mr. H. F. Moore, E. C. Marsh, and others. Entomology will be cared for by Mr. August Brusck, of the Department of Agriculture, while Mr. A. B. Baker will represent the National Zoological Park. Mr. A. H. Baldwin goes as artist.

Dr. Carl Aurivillius, of Upsala, left Stockholm on January 6 to renew his observations in Java, the Sunda Islands, and possibly Timor. He will make general zoological collections in this interesting but still little known region, and make special studies on the fauna of coral reefs. While on his voyage he will conduct researches on the plankton of the Indian Ocean and the sea around the Sunda Islands. The expense of this will be paid out of the Lars Hierta Memorial Fund; but the general cost of the expedition will be defrayed by the J. A. Wahlberg stipend (awarded for the first time) as well as the larger of the State travelling stipends.

Prof. A. C. Haddon writes to *Nature* that his expedition has now completed its work in Torres Straits. Dr. Rivers and Mr. Wilkin have left for England, while the other members of the expedition have proceeded to Borneo to study the anthropology of the Baram district of Sarawak. The health of the party has been excellent.

The natives of Murray Island were studied with most detail, as, owing to their isolation, they have been less modified by contact with alien races. Some of the party stayed about four months on the island, others only a couple of months, having made a trip to the mainland of New Guinea, where they visited the coast tribes between Kerepunu and the Mekeo district, and took several excursions for short distances inland. There was not enough time spent at any spot for a thorough investigation of the natives, but a considerable amount of information was obtained in most of the branches of anthropology with which the expedition is concerned; and this will prove of value for purposes of comparison. Over a month was spent in Mabuiag (Jervis Island) by all the party, with the exception of Messrs. Myers and M'Dougall, who had previously started for Borneo. Although the time spent in Mabuiag was short, a satisfactory amount of work was accomplished, owing to the conditions being favourable. Observations were also made on several other islands in Torres Straits and in Kiwai, which is situated at the mouth of the Fly River.

A large number of photographs have been taken, and considerable collections, which are now on their way to Cambridge, have been made.

Dr. C. F. Millspaugh, the botanist, and E. P. Allen, the photographer, of the Field Columbian Museum, Chicago, left New York on December 24 for the West Indies on Mr. Allison Armour's yacht "Utowana," in order to make as complete a collection of the flora as possible.

In a letter to *Aftonbladet*, Mr. Stadling of the Andrée Search Expedition, complains that his telegram from Yeneseisk was transmogrified beyond recognition, and gives the following account of his travels:—After 300 miles stormy voyage through the delta, they were frozen up on an uninhabited island in the sea west of the Lena delta and about 100 miles from the mouth of the Olensk. After seventeen days they were able to obtain dog-sledges from the interior and to proceed over the sea. Reindeer took them from the mouth of the Olensk over 300 miles of uninhabited tundra to Anabar, thence in a north-westerly direction near to the mouth of Chatanga Creek, and so southwards to Chatangskoje. Crossing the Taimyr peninsula, they took a more northerly direction

than the usual winter road of the hunters, so as to visit the natives, who were still out on the tundra. The route led over the watershed between the rivers Chatarya, Taimyr, and Pjasina, to Dudinskoje on the Yenesei, about 1800 miles from the Lena delta. Thence reindeer and horses took them 1200 miles to Krasorojarsk, where they took the train on December 2. None of the natives or wandering Dolgans and Samoyedes had any news of Andrée, though a few had heard tell of the expedition three years before.

Another Andrée rumour comes through Prof. Nathorst of Stockholm. Fourteen days before midsummer, the Norwegian whaler, "Harald Hårfager," was in the ice between Iceland and Greenland, in 66° 33′ N. and 28° W., when the crew of one of her boats saw on an ice-floe a large mass like a heap of brushwood or a pile of steel rails. Fog and the fear of losing their ship prevented a closer examination; and though the captain, when it was reported to him, lay to for several hours and then steered in the direction indicated, the mists prevented rediscovery of the curious appearance. It was not till later that this object was connected in their minds with Andrée's balloon. This, however, is a possible explanation, for, supposing the balloon to have met with mishap north of Spitzbergen, it would have drifted across to Greenland and then down its east coast.

The well-known traveller, Captain Daniel Brunn, has decided to organise an expedition next summer to search for traces of Herr Andrée and his companions in the neighbourhood of Eastern Greenland. The expedition will start from the east coast of Iceland and proceed by way of Jan Mayen Island, to the vicinity of Cape Barclay on the east Greenland coast.

The interesting results obtained by the expedition of Mr. J. E. S. Moore to Lake Tanganyika have led to the formation of a committee to organise another expedition for the purpose of thoroughly surveying the basin, not only of Lake Tanganyika, but also the northern extension of the series of valleys in which this lake, along with Lake Kiou and the Albert Nyanza, lie; of collecting specimens of the aquatic fauna and flora, and of studying the geological history of the region. The last-mentioned object is of special interest, considering the marine Jurassic character of the gastropods now living in the lake. The likelihood of the halolimnic fauna, as Mr. Moore calls it, being found in the lakes to the north is increased by the fact that it bears some resemblance to the fauna of the Lower Nile. The proposed expedition would go northwards from Tanganyika as far as the Albert Edward and Ruwenzori districts, then eastwards down the Uganda roads to the sea. The African Lakes Corporation is now running a steamer on Tanganyika, and this will permit of dredging and sounding. The Committee consists of Sir John Kirk, Dr. P. L. Sclater, Sir William Thiselton Dyer, Prof. Ray Lankester, and Mr. G. A. Boulenger. It estimates that at least £5000 will be required, and appeals for pecuniary support.

A telegram from Sydney has been received at the Royal Society, stating that the boring into the coral reef, or rather atoll, of Funafuti had been discontinued on reaching a depth of 1114 feet. Cores had been obtained, and the material traversed is described as "coral reef" rock. By comparison of this information with that previously received it would appear that the lower part of the mass pierced consists of a hard limestone, apparently reef material, a rather sudden change from softer and more variable stuff—a mixture of sand composed of calcareous organisms with reef coral—taking place at a depth just short of 600 feet.

Another attack on *Polypterus* in the Nile valley is to be made this year by Prof. E. B. Wilson of Columbia University.

Lord Lister and Sir Henry Roscoe announce that Lord Iveagh has offered the sum of £250,000 for the purposes of the highest research in bacteriology

and other forms of biology as bearing upon the causes, nature, prevention, and treatment of disease. He has proposed to the Council of the Jenner Institute (lately the British Institute) of Preventive Medicine, that the donation shall be handed over to the Institute on condition that in future the control and management of the affairs of the Institute shall be placed in the hands of a new Board of seven trustees, three of the seven to be chosen by the Council of the Institute, three by the donor, and one by the Council of the Royal Society. The offer has been cordially accepted at a meeting of the Council.

The donor further proposes that part of the new fund shall be appropriated to the enlargement of the buildings of the Institute at Chelsea, part to increasing the at present sadly inadequate salaries of the director and other members of the scientific staff, part to the expenses of administration and maintenance, and the remainder chiefly to founding valuable fellowships and studentships, tenable for limited periods, for research either in the laboratories of the Institute or in the centres of outbreaks of disease, whether at home or abroad.

The executors of the late M. Dobrée of Nantes, the shipbuilder, who left a fortune of 13,000,000 francs, have, in accordance with his wishes, bought a large mansion, with a park of 37 acres, and presented it to the town of Nantes for the foundation of a School of Colonial Horticulture, to endow which a sum of one and a quarter million francs is also bequeathed.

The official organ of the Prussian Ministry of the Interior gives some account of the work accomplished, since its constitution three years ago, by the German Central Committee for the establishment of sanatoria for consumptives under the patronage of the German Empress and the presidency of the Imperial Chancellor, Prince Hohenlohe. The great object of the Central Committee was to establish a sufficient number of sanatoria throughout the German Empire, and in this they have met with much encouragement and success.

The Rev. G. Procter, a retired schoolmaster, has bequeathed £3000 to the University of Aberdeen as a contribution to the erection of an observatory at King's College.

We learn from *Science* that the Bussey Institute, Harvard University, has received from Mr. E. D. Morgan $5000 for the equipment of a pathological laboratory, of which Professor Theobold Smith is the director; also that a new greenhouse, costing $7000, has been given anonymously to the Botanical Garden of the University.

We learn from *Science* that the late Mann S. Valentine bequeathed to the town of Richmond, Virginia, his collections of books, MSS., paintings, and anthropological specimens, with his own house to serve as museum-building. This is to be associated with the educational institutions of the State, to publish literary and scientific papers, and to preserve objects of antiquity.

The Thakoor of Gondal, lately a medical student at Edinburgh University, has spent £30,000 on a college "of the type of Eton," which Lord Sandhurst opened the other day.

The Free Library, Museum, and Technical School of Bootle have started a *Journal* for the use of their visitors. It will serve, in the first instance, as a quarterly supplement to the library catalogues, and should do much to help readers to a right use of the library. We learn from it that the re-arrangement of the birds in the museum, under geographical regions, is now nearly finished, as also is the labelling with popular names. There will also be an arrangement of birds in families, according to Claus's "Text-book of Zoology." The arrangement is described in a threepenny handbook. In connection with this a course of six lectures on birds is being given to school teachers. In the same room as the birds are exhibited the invertebrates.

The University of Pennsylvania has determined to establish an experimental menagerie under the direction of Professor Edward J. Conkling, where

the animals will be permitted to live under the most natural conditions. Experiments will be made to discover how animals communicate with one another, whether they reason, whether domestic animals have increased powers of expression, whether animals, as a class, dream, and so on. Much attention is to be given to the night-flying animals and birds, of which so little is known.

The *Lancet* reports the appearance of a veritable giant in the subalpine town of Cuneo, who is a phenomenon deserving of more than vulgar curiosity. This overgrown individual is a native of the Piedmontese hamlet of Vinadio, where he was born twenty-two years ago. His altitude is (in metres) 2·25, his thoracic circumference is 1·60, and his feet are 45 centimetres long.

"The Resources of the Sea; or, An Inquiry into the Experiments on Trawling and the Closure of Areas," is the title of a work by Prof. McIntosh (C. J. Clay and Sons, Cambridge University Press Warehouse), to be issued shortly. The work gives the results of many years' experience in the department—from Lord Dalhousie's Commission (1883-85) onwards. It commences with a general sketch of the resources of the sea in the various groups, then reviews the Trawling Report of 1884, the present condition of the fishing-grounds and the fisheries, and comments on the changes which have since occurred in vessels and their equipment. The mode in which the trawling experiments have been carried out by the Scotch Fishery Board is then dealt with in connection with the closed areas, and as the author suggested these closures for experiment, his criticisms have some interest. The whole series of the experiments in St. Andrews Bay, the Forth, the Moray Frith, and the Clyde are minutely reviewed and criticised, and, finally, conclusions are drawn in accordance with the facts. These conclusions are adverse to the closure, and show that the influence of man in regard to the destruction of any marine food-fish on an open seaboard is comparatively insignificant. The work is accompanied by thirty-two tables and various photographs and figures.